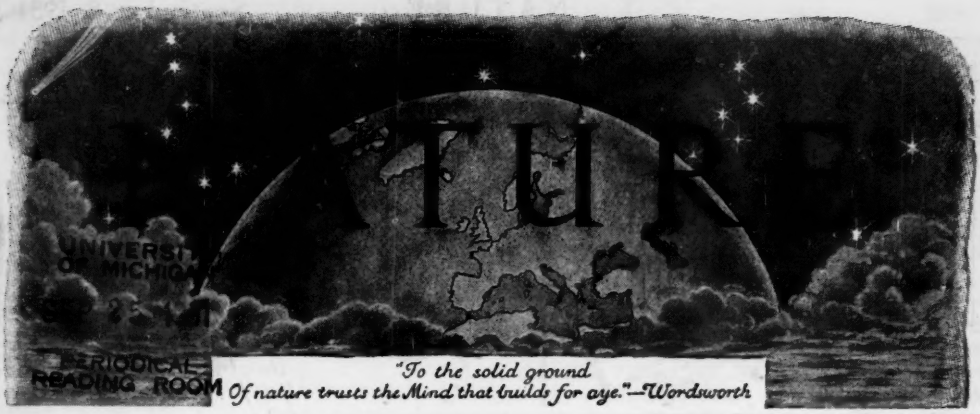

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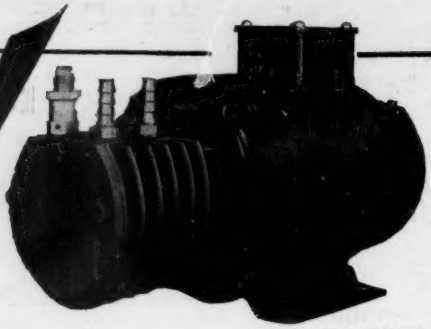

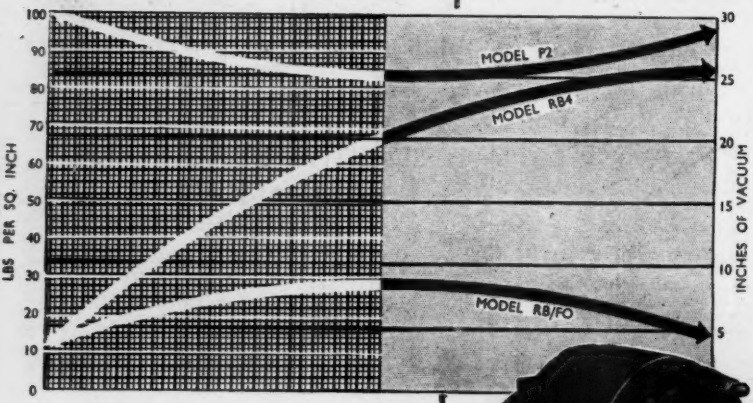

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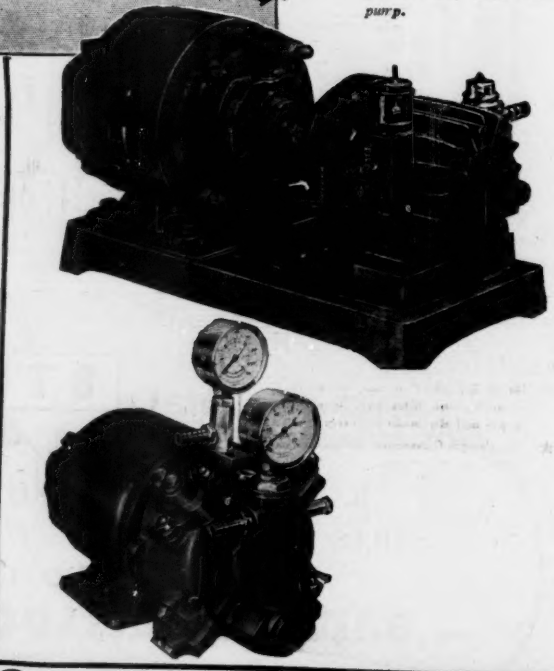

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EDUCATION IN THE COLONIES

NOT many years ago those charged with educating the people of the Colonies often came in for considerable criticism. They were frequently told to leave well alone because the Colonial peoples were happy as they were. To-day it is generally realized that Colonial peoples are not happy as they are; they are demanding education, and it should be wisely conceived and generously provided.

Modern conceptions of education in the Colonies usually fall into two main classes, and these have been discussed in an article by W. E. F. Ward (*Universities Review*, **23**, No. 3; May 1951). The first conception is political. The Colonies are being educated for self-government within the British Commonwealth of Nations. Self-government is the accepted aim of British Colonial policy; but it is a difficult art, and it would be a mockery to grant political power to people who were not educated to use it. Moreover, a politician, however familiar he may be with Plato, can do little these days without technicians. He needs not only engineers and medical men, but also trained administrators, actuaries, statisticians, and, possibly, public relations officers. To make self-government possible, these men must be trained, and the educational system must be designed to train them. To put self-government as the aim of the educational system takes us a good way in educational thinking and practice.

The second conception of education arises out of the poverty of the Colonies. Their mineral resources are far from being explored; their agriculture could be more productive; their communications are inadequate; they have little manufacturing industry. Their prime need is to develop their natural resources. For this they will need three things: capital, hard work, and knowledge; and two of the three, the hard work and the knowledge, should come from their education, which should be devised to bring rapid economic and social development.

Both these conceptions of Colonial education must be considered in relation to existing circumstances and show that they need to be vigorously pursued. More and more educated Colonial peoples are demanding political responsibility; the remainder must be educated to make self-government possible. More and more natural resources are being devastated through ignorance; the Colonial peoples must be educated both to use and conserve their resources wisely. Colonial educationists are thus fighting not only against human ignorance and wilfulness but also against time.

After paying generous tribute to the work of Christian Churches in Colonial education, Mr. Ward shows that to-day it is men and women of the Colonial Education Service who have most of the responsibility for planning and directing education in the Colonies.

The Colonial Education Service is a unified service: that is to say, its members can pass from one Colony to another, their service being counted as continuous, and their pensions, calculated on a uniform basis, accumulating as the years go by. On the other hand, the Service is far from being unified in the way

that the Fighting Services are. It is not appointed and paid from London. Its members are selected by the Secretary of State for the Colonies; but they are appointed by the Governor of the Colony in which they serve, and are paid salaries, fixed by the Colonial Government, from taxes raised in the Colony. It would no doubt be simpler to pay everybody from United Kingdom funds, with suitable local allowances, and to post a man where he is needed. But that would be most unwelcome to Colonial Governments. They like to be masters in their own house: to appoint their own servants, to pay them, and (subject to certain Civil Service safeguards) to control them.

Every British Colonial territory has an educational system, though there are patches in some of them, like the nomadic Somali and Masai tribesmen, where education has not penetrated. Everywhere there is an education department, presided over by a director of education with some sort of educational advisory board. There are primary schools, a few good infant schools (but no nursery schools), secondary schools, teacher training centres and some technical schools or colleges. There are seven Colonial university colleges; but these are not staffed by the Colonial Education Service. Britain does not believe in Government universities.

Except in a few of the smallest territories, there is no compulsory education, for neither the Government nor the Churches can afford to provide schools and teachers for all the children. This is where the Colonies are handicapped by their poverty, by sheer lack of taxable resources. In the big African territories, only a minority of the children can go to school at all. The quality varies. A few of the schools are very good, some are mediocre, many are just bad. There has not been money to provide adequate buildings, especially expensive buildings like science laboratories, workshops and libraries. Consequently, education tends to be much too 'bookish'; this puts severe limitations on the training of local teachers. Nor is there enough money to provide an adequate staff of teachers from overseas.

Yet it would be wrong to imagine that these schools are useless. There is nothing wrong with them that could not be put right by a grant of £50,000 for buildings and equipment, and an annual grant for additional staff salaries. The trouble is that the local Governments have not got the money. They prefer to have one or two really good schools, which can serve as models for the others to copy, and can be used as training centres for teachers from elsewhere. These schools are often very good indeed, as regards staffing, building and equipment.

All this means that the man in the Colonial Education Service, whether teacher or administrator, is kept on the alert. He is always making bricks with the minimum of straw. He has to turn his hand to anything, to improvise. His work is exhausting; but immensely stimulating and worth while.

Teaching and administration are the two main functions of the Service. People often pass from teaching to administration, and sometimes back from administration to teaching. In most territories, the primary school teachers are all locally born. In the infant schools there are still some head teachers with a Froebel or similar qualification who are recruited in Great Britain and are members of the Colonial Education Service. In the secondary schools, and still more in the teacher training centres, there are in the aggregate large numbers of graduate teachers, and it is the normal practice for all newly appointed members of the Service to be posted first to classroom teaching.

The bush education officer has no exact counterpart in Britain. He may be responsible for the general educational efficiency of a district which may be as big as Scotland or as small as Rutland. There may be in his district a Government or Church secondary school with one or two Europeans on its staff, or even properly qualified locally born teachers. There will certainly be other professional colleagues—a district commissioner, an agricultural officer, and a medical man. He may be able to persuade them to help him now and again in some special project, such as a holiday refresher course for the primary school teachers. His work will be a never-ending round of visiting schools, inspecting the state of equipment, listening to the teaching, advising and helping the teachers and often giving a demonstration lesson himself, assessing the schools' eligibility for grant and checking the finances, planning extensions to buildings and planning new schools and collecting the teachers for holiday courses.

The bush education officer is in some ways the key man in the educational system. It is very largely a matter of his personality whether the schools in his area are active or stagnant. This is mainly due to the inadequate education and professional training which most of the staff have received. Many of them have excellent capacities; but too often they have had so little opportunity that they have been able to do nothing but acquire knowledge and a few stereotyped ideas on method and technique. The education officer has to draw out of them what he feels they have in them.

He is like the local education authority's representative in that he is the superior officer of the Government teachers, and has scarcely less power over the teachers in the assisted or unassisted Church or native authority schools. He is in close touch with the mission or other employing body; he can recommend that the school's grant be increased or diminished, that an unassisted school be placed on the assisted list or told to wait. In dealing with missionaries or local government bodies, he is like British school inspectors in being able to give them advice on the condition of their schools. If they need to spend money he cannot compel them to do so; like the divisional executive in Britain, he has to persuade them. The man who can keep his teachers up to scratch, keep on good terms with his Government colleagues in half a dozen different departments and with the representatives of half a dozen assorted missionary societies, persuade a group of canny village elders that if they want a school they must build it themselves, lay his plans for educational expansion and get them accepted by his departmental chiefs and the advisory board at headquarters, could

fill most positions in the educational world adequately enough.

The curriculum in schools and colleges is often determined by two considerations: the first, that the pupils have to be prepared for all the multifarious techniques that a modern civilized State requires; the second, that education must be rooted in the pupil's ancestral culture. To some extent these two considerations come into conflict. The dominant European culture has such an attraction for the pupils that they tend to resent anything which diverts their attention from the full-time occupation of studying it. It is not that in general they are hostile to their own culture, though such hostility is a phase which some of them pass through; but most of them would gladly be learned in the lore of their own people if they could become so without giving up the new learning which comes to them from the West.

Hence the greater part of the curriculum reads like a copy of the curriculum in Great Britain—as, in fact, it is. Here and there it is possible to make minor local modifications. Local history and geography play a part in the courses, and are offered in the Cambridge examinations. There was a time when English earthworms and dandelions were sent out on ice to be dissected by African candidates in biology examinations; but they have long since been replaced by local types. Work in art, music and housecraft is often based on local conditions and local culture. But it is not possible to make much variation in an educational system which has to train engineers, medical men, lawyers, accountants, professional men and technicians of all kinds. Students in the Colonies naturally demand professional qualifications that are recognized in Great Britain. The place for local culture seems to be rather in the study of the local languages and literatures, and in school organization and out-of-class activity, than in the study of subjects which are designed to lead to the acquisition of distinctively Western skills. There is no doubt that indigenous culture will have to play a larger part in Colonial education in the future than it does now. One of the great services which the new Colonial universities will be able to render is in undertaking the necessary study of indigenous cultures and in building up a new civilization based on a blend of the indigenous culture with that of the West.

The lack of cultural background is felt over a much wider field than the study of the arts. Except in a few special cases such as the Caribbean, Western education tends to draw the children away from their own social background. Many of them come from illiterate homes, and their parents aspire to see them appointed to a well-paid Government post, preferably one which does not involve hard physical work. The first effect of schooling is thus often to take a child right out of touch with the primitive life in which his parents still live. As a result many critics say that in a territory where agriculture must for many years remain the principal industry and source of revenue, people ought to realize that they are needed on the land; and there must be something wrong with an educational system which enables—or even encourages—people to leave the land and flock to the towns.

The critics, of course, are crediting the school-teacher with a good deal more influence than he has, and they are ignoring a good deal of human nature. To get boys into the mines in Britain one thinks in terms of wages, holidays with pay, housing, pit-head baths and canteens. It will have to be the same in the Colonies. Young people will never be kept on the land by setting school-teachers to preach at them about the importance of agriculture.

Nevertheless, the educationist must do what he can to avoid this unhappy cleavage between educated young people and their rural background. There is little that he can do in modifying his curriculum; but he can set up various adult-education movements and various types of youth work to enable ignorant parents to comprehend the purpose of school education and to enlighten those who remain behind in the villages. This side of education is still in its infancy.

Enough mass education work has already been done, however, to show the possibilities that are waiting to be realized if men and women can be found to undertake it. Tribesmen in Nigeria have built themselves roads and bridges and all sorts of public buildings, from market halls and co-operative shops to maternity clinics. The demand for reading-matter in six different languages among recent illiterate workers in the Rhodesian copper belt kept the printing presses on the strain. In the Caribbean and in East Africa people have begun by realizing with a shock that the school could teach them something even on their own subject of farming, and they have gone on to profit by this discovery in improving their nutrition, their health, their home life, and their general community spirit. Mass education has great possibilities, and might, in fact, go a long way towards healing the rift between formal education and real life. But there is nothing like enough of it yet.

Mr. Ward also shows that educational research in the tropics is an almost untouched field. Visual aids, intelligence tests, English as a foreign language, curriculum and organization, relationship between school and home are only a few of the outstanding topics on which many people have views based on experience, but on which scarcely anyone has yet done any proper research. There is great need of research workers, and this, too, is a field in which it is hoped that the new Colonial university colleges with their institutes of education will be able to help.

THE ESSENTIAL OILS INDUSTRY

The Essential Oils

By Dr. Ernest Guenther. Vol. 4: Individual Essential Oils of the Plant Families Gramineæ, Lauraceæ, Burseraceæ, Myrtaceæ, Umbelliferæ and Geraniaceæ. Pp. xiv+752. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 90s. net.

THIS volume follows the same plan, and achieves the same excellence, as its predecessor (see *Nature*, 166, 753; 1950). The oils here dealt with, however, being predominantly products of the eastern hemisphere, and indeed of the Far East, illustrate in a much more striking fashion the contrast between

highly modernized and wholly primitive methods of production, which is so marked a feature of the essential oils industry as a whole.

Palmarosa, cassia and lemongrass provide examples of oils in which the organization and technique of production can have altered little since the era of bulging galleons and buccaneering raids, so pleasantly touched into the background of Dr. Guenther's account of cinnamon and clove. Such oils, obtained from herbs or small shrubs, are highly seasonal in output, and produced in scattered locations, defined partly by ecological suitability for the oil-bearing crop, and partly by unsuitability for any more immediately profitable husbandry. These factors, added to the bulky nature of the crop, and the low weight-proportion of the oil, which is the only valuable part of it, preclude the steady flow and concentration of raw material which alone could offset the capital expense of a modern processing plant. So far as such oils are concerned, therefore, production of essential oils remains a peasant industry, based on the most unambitious standards of living and the crudest distillation equipment, and liable to great unevenness or total interruption of output when political unsettlements compel the peasant's attention more exclusively to his immediate needs of livelihood. The connexion is clearly illustrated by the decline of the Algerian geranium oil industry, linked with the progress of Algiers from colonial status to that of a department of France. In Réunion, under social conditions which Dr. Guenther judiciously describes as "feudal", production of geranium oil maintains its economic equilibrium.

In contrast are the developed industries based on camphor and eucalyptus, each so completely a subject in itself that even such a coinage as "eucalyptologist" must be accepted as a necessary evil; and Dr. Guenther has been wise and fortunate in leaving the appropriate monographs in the hands of specialists, co-ordinated by Dr. T. Hiraizumi, of the Takasago Chemical Industry Co. of Tokyo, and Messrs. A. R. Penfold and F. R. Morrison, of the Museum of Technology and Applied Science, Sydney. The camphor industry, it is true, can show a lineage comparable with that of cinnamon itself; to the Formosan woodcutter, the largest camphor tree in the forest is still a shrine, and each lesser tree a spirit, not to be insulted without offerings of propitiation; but between the forest and the market, Japanese activity, in response to the challenge of artificial camphor, has interposed an organization of singular completeness. The status of the tree as a vegetational dominant over large areas permits of a more systematic harvesting and replacement, and a more thorough study of botanical variations, than is possible with grasses and herbs. To this has been added the utmost possible utilization of all constituents of the crude produce, export or consumption of which without fractionation was prohibited by the Japanese Monopoly Bureau. The number and variety of 'cuts' and isolates from camphor oil may indeed become confusing, and Dr. Hiraizumi's clarification of the subject is accordingly welcome.

Except in respect of its antiquity, the eucalyptus industry stands on a similar footing. Potentially it is capable of even wider expansion, since the very numerous species of the genus show a greater variety among themselves than is often found between oils from different genera or even different families. As examples may be quoted *E. polybractea*, yielding medicinal oil with up to 90 per cent of cineole; *E. numerosa*, with up to 80 per cent of phellandrene, used industrially in ore flotation; and the perfumery oils of *E. macarthuri* and *citriodora*, containing respectively up to 70 per cent of geranyl acetate and 80 per cent of citronellal. Even morphologically indistinguishable trees growing within a few feet of one another may yield wholly different (cineole-rich or piperitone-rich) types of oil. Confusion may be increased by commercial practice in giving a blended oil the name of a single species if it is of the type traditionally associated with that species; for example, *E. globulus*, even though it is well recognized that unmixed oil of that species is not, in fact, marketed from Australian sources. Penfold and Morrison's painstaking comparative review of some two hundred and fifty specific names in the genus is therefore not the least valuable part of their contribution.

The future of the primitive types of essential oils industry is obviously somewhat problematical. A fuller utilization of the raw material would seem to be the first condition of survival. Uses can be found even for the spent material, as, for example, the production of paper in Guatemala from lemongrass leaves after distillation. Improved distillation technique may multiply the number of products, as with the fractions of camphor oil, or improve the yield of specially valuable constituents such as the citral which, through the intermediate stage of β-ionone, hitches the wagon of lemongrass oil to the commercial star of synthetic vitamin A. It may be that in some cases such a degree of development implies no less than the bodily transplantation of the old industries to distant sites where they will constitute staple instead of spasmodic occupations, and where lay-out and transport are specifically adapted to their purposes; and Volume 3 of this work affords evidence that such a solution is physically possible. Dr. Guenther's book will then seem out of date; but scarcely, one may suppose, before then.

E. G. Kellett

FRESHWATER PHYTOPLANKTON

Die Binnengewässer

Band 16: Das Phytoplankton des Süsswassers; Systematik und Biologie. Von Dr. G. Huber-Pestalozzi. Teil 3. Cryptophyceen, Chloromonadinen, Peridineen. Pp. ix+310+69 plates. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 1951.) 67 D. marks.

THE great importance of freshwater phytoplankton in limnological studies has long rendered desirable a taxonomic treatment of the organisms involved. Such a phytoplankton flora was indeed planned by those responsible for the publication of the valuable "Süsswasserflora Deutschlands, Oesterreichs, etc.", although it never reached completion. Huber-Pestalozzi's work, forming part of the series of Thienemann's "Binnengewässer", thus fulfils a useful purpose in supplying this long-felt need. The parts already published (Teil 1, 1938; Teil 2 in two separate portions, in 1941 and 1942), which, apart from containing a general introduction, have dealt with the Myxophyceæ, Bacteria, Fungi, Chrysophyceæ, colourless Flagellata, Xanthophyceæ and Diatoms, have not been available for review. The entire work to date costs about 260 D. marks

(upwards of £20) unbound, and three further parts are planned. It will be clear that the cost is almost prohibitive for the private individual, and it may be questioned whether a treatment on a less ambitious scale would not have been more valuable. The need is for a work of a less-expansive character that could be published at a price which would render it accessible to more than libraries and institutions.

The particular part under review deals in the first place with the Cryptophyceæ and Chloromonadineæ, of which no detailed systematic treatment has appeared since that of Pascher in the "Süsswasserflora" (1913). Scherffel's problematical genera *Monomastix* and *Pleuromastix*, the affinities of which are hard to assess, are grouped as a sub-class Monomastigineæ, the remaining Cryptophyceæ forming the sub-class Cryptomonadineæ. The latter are urgently in need of a critical revision, as Pringsheim (1944) has pointed out, and the material brought together by Huber-Pestalozzi will afford a basis for future work on the group. The author provides a useful key to the thirty-two described species of *Cryptomonas*. In the treatment of the Chloromonadineæ no reference is made to recent French work (Chadefaud 1937, Hovasse 1945), especially that relating to *Gonyostomum*, from which better figures than that of Stein of *G. semen* could have been obtained. The author appends to the account of the Chloromonadineæ a discussion on trichocysts which both French authors have studied in some detail. The greater part of the volume is concerned with the important planktonic group Peridinieæ, of which Schiller has comparatively recently (1931) given a detailed systematic account in Rabenhorst's "Kryptogamenflora". The restriction to freshwater species and the provision of detailed keys for such large genera as *Gymnodinium*, *Glenodinium*, and *Peridinium* will make Huber-Pestalozzi's treatment useful to workers on freshwater plankton.

The majority of the 350 illustrations are reproductions and, especially among Cryptophyceæ and Chloromonadineæ, the absence of fresh figures is disappointing. The bulk of the figures are grouped as plates on stiff paper, which must have added to the cost of the work, although most of them could equally well have been reproduced in the text.

F. E. Fritsch

TECHNOLOGY OF ALUMINA PRODUCTION

Tonerde und Aluminium

Ergebnisse und Erfahrungen aus der Betriebspraxis, 1920–1950. Von Dr. Wilhelm Fulda und Dr. Hans Ginsberg. Teil 1: Die Tonerde. Pp. viii+226. (Berlin: Walter de Gruyter und Co., 1951.) 26 D. marks.

THE publisher's notice of this authoritative work states that it is intended to provide what has as yet been lacking—a comprehensive account of the actual working practices of the alumina and aluminium industries. The present volume, on alumina production, certainly fulfils this intention.

While omitting mention of many processes now only of historic interest, it contains much more quantitative information on current operations than did Edwards, Frary and Jeffries's standard work, published in 1930.

After reviewing in detail the properties of European bauxites and to a less extent those of other countries, the book devotes nearly eighty pages to the development in Germany, during a period in which German aluminium production was expanded from about 14,000 tons (in 1920) to 260,000 tons (in 1943), of the classical Bayer process for extracting alumina from bauxite with caustic lye, and its modification the so-called 'tower process'. There follow some fifty pages describing the alternative 'sinter-alumina' process in which the bauxite is heated with sodium carbonate in a rotary furnace; methods of extraction, due to Pedersen and others, in which lime is the extracting agent and still higher temperatures have to be used; and such processes as that due to Haglund, which have as their object the removal of impurities from the bauxite rather than the direct extraction of the alumina itself. The remainder of the book is devoted to processes for extracting alumina from clays and other aluminosilicates.

The book is systematic, essentially practical from the point of view of the chemical engineer, and engagingly clear. It is well provided with flow diagrams and other illustrations. It has behind it the authority of two authors well known in the industry. Dr. W. Fulda died in September 1950; and while the surviving author acknowledges the collaboration of colleagues in the Vereinigte Aluminium–Werke A.G., the book achieves a noteworthy unity of presentation.

All who are concerned with the technology of the primary aluminium industry will welcome this book and will look forward keenly to the appearance of the succeeding volume, which is to deal with the production of the metal.

PRODUCTION OF GLASSHOUSE CROPS

Science and the Glasshouse

By William J. C. Lawrence. Second edition, revised. Pp. xiv+176+4 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1950.) 15*s*. net.

THIS book is divided into three parts: (1) the John Innes composts, (2) methods of cultivation, and (3) natural illumination in glasshouses, and gives an account of work done at the John Innes Institution on these subjects. Indeed, it is a progress report on experimental work carried out by Mr. Lawrence and his colleagues.

So far as Part 1 is concerned, little need be said; the John Innes composts for seedlings and growing plants are now widely used by growers, and there is no doubt that considerable improvement in plant production has thereby been brought about.

Part 2 deals with several fundamental aspects of plant production, for example, size of pot, firm or loose soil, watering, soil temperature for potting, type of benching in the glasshouse, etc. These are all factors in which tradition has decided the correct way, and tradition dies hard. Moreover, it is probable that tradition will govern many of these factors for some years to come, for to many growers of the 'old school' these new ideas are not welcome. Apart

from this diehard attitude, there are several considerations which must be taken into account by the commercial grower. For example, the size of pot into which a plant is potted is very often governed by the space available; this is particularly true in the case of the grower of decorative plants for sale in pots.

The skill of the worker under whose care the plants are placed is a most important factor which cannot be assessed experimentally, but which has a profound influence on the ultimate result. It has frequently been said that the horticultural worker who cannot use the watering can or hosepipe efficiently and intelligently cannot grow a good plant or produce a good crop. There are many similar variable factors in plant production which cannot be standardized except by the most elaborate equipment, but which are controlled to some extent by the human factor. Therefore, however far the fundamental processes of horticulture are standardized the human factor will ultimately decide the quality of the plant.

Mr. Lawrence has, in the experiments described, blasted tradition; he has opened up new lines of approach to many problems; but it is very necessary that the experimental results shall be linked with the economics of plant production, and further experiments on these lines are necessary.

In the last part of his book Mr. Lawrence has explored new ground and has collected together a vast amount of data on the natural illumination of glasshouses. The information given is of great value and has already influenced the design of glasshouses. The importance of light in the production of winter crops is emphasized and suggestions are made for obtaining improved winter illumination. It is difficult to understand why work has not been done previously on this and many other problems concerning glasshouse construction.

This is a book which is stimulating and, in many ways, provoking. It should be read by all who are interested in the production of glasshouse crops, for in it they will find considerable food for thought.

Mr. Lawrence is to be congratulated on the production of this book, which is a contribution to the fundamental knowledge of glasshouse crop production of very real value.

WILFRED CORBETT

TECHNOLOGICAL RESEARCH IN SWITZERLAND

Industrial Research in Switzerland

Its Institutional and Economic Background. By Prof. Ronald S. Edwards, in collaboration with Charles La Roche. Pp. ix+111. (London: Sir Isaac Pitman and Sons, Ltd., 1950.) 21*s.* net.

PROF. R. S. EDWARDS has followed his earlier study of the economic aspects of the research associations in Great Britain with a study, in collaboration with Dr. C. La Roche, of the Federal Institute of Technology, Zurich, of the organization of industrial research and development in Switzerland. The book is based on a survey of Swiss industrial research institutions, together with discussions with firms, research institutions, universities and government departments, and includes some information not elsewhere available. There is a select bibliography, prepared by Dr. C. La Roche, and much useful information is collected in the appendixes, dealing with research foundations, the scientific societies and the government research institutes.

The book appears to be designed as a contribution to current discussions on the increases of industrial productivity. It first briefly outlines the industrial pattern of Switzerland and the extent to which research is fostered in industry. This is followed by a chapter on the universities and industry, in which some comparison is made between Swiss and British universities, and the relations between industry and the universities in Switzerland are discussed. A chapter on institutions for co-operative industrial research makes good a gap; the remaining chapters deal with the Federal Government as a sponsor of research, and with research, taxation and the patent system, and finally Prof. Edwards attempts to outline the general influences in Swiss life that must be taken into account in seeking the root causes of Swiss industrial achievement.

One merit of this book is that, although it makes many suggestive comments on the differences between the pattern and practice of industrial research in Great Britain and in Switzerland, Prof. Edwards never attempts to push the comparison too far. He is fully aware of the differences in definition, for example, which may make comparison between one industry or one country and another misleading, even where figures exist as a basis. The chapter on the universities and industry may well prove to be the one of most general interest, and its account of science and technology in the universities has a bearing on discussions on higher technological education in Britain. It appears from the analysis presented here that, out of its relatively larger university population as compared with that of Great Britain, Switzerland has a higher proportion of students reading applied science and technology, and that the difference has become more marked since the Second World War. On the other hand, Great Britain spends more per student and the ratio of staff to student has increased slightly, whereas in Switzerland it has decreased appreciably since before the War.

Prof. Edwards's comparison between Switzerland and Great Britain is not unflattering to the latter; but it does not encourage complacency. He points to some weaknesses in the Swiss system, particularly in regard to fundamental research and the lack of openings in academic life. He suggests that a full-scale study of Swiss technical schools, and especially of the Federal Institute of Technology, their organization, administration, curricula and relations with industry, both in regard to training and research, would make a more important contribution to the current debate in certain circles in Britain on the future of technological education than a study of the relations between industry and the universities in the United States now being investigated by a team under the Anglo-American Productivity Council. The great problem, in his view, which Great Britain has not yet fully solved, is how to adapt middle and higher education to meet the needs of the large number of students who must find—and who it is hoped will want to find—their careers in the middle and upper ranks of industry and trade. Prof. Edwards does not claim that his present essay is more than a sketch. Whether or not it stimulates the further inquiry he suggests, it should at least assist in keeping on a factual and practical basis future discussions on productivity and on technological education.

R. BRIGHTMAN

Physical Chemistry

By A. J. Mee. Fourth edition. Pp. xix+753. (London: William Heinemann, Ltd., 1951.) 25*s*.

THIS well-written book has for years been recognized as a standard introduction to physical chemistry for university students. By resetting the type and by some rearrangements, the publishers have shortened the book by twenty-nine pages: otherwise there is very little alteration from the 1947 edition. The new matter amounts in the aggregate to two pages only; of these, one page is given to chromatography and the other is made up of some additions to a few chapters each too small to be of much value. Further, the author has deleted two adversely criticized pages dealing with the theory of ionic discharge and has not filled the gap. With the uneven advance of knowledge this policy of leaving well alone is highly questionable. For example, the small and unchanged section devoted to artificial radioactivity is now out of all proportion to the very numerous papers appearing on this subject. Again, as the author has left his discussion of nuclear fission unchanged from 1947, he still makes no mention of plutonium and neptunium, of Powell's work on mesons, of the production and use of radioactive tracers, or of polarography. Accordingly, it is astonishing to read the publishers claim that the book has been "revised throughout" and that the treatment of nuclear fission is "up-to-date". Finally, throughout the book the bibliographies are now behind the times.

G. FOWLES

Intermediate Practical Chemistry

By Sylvanus J. Smith. Pp. vii+248. (London: Macmillan and Co., Ltd., 1951.) 8*s*. net.

TO the text-books already to his credit Mr. S. J. Smith has now added a complete practical chemistry intended for the advanced course in schools and for classes of a similar standard. In selection and treatment the author keeps mostly to the classical tradition; but he occasionally introduces a novelty. Thus in the section on volumetric analysis (83 pages), students are encouraged to prepare standard sodium carbonate by a laboratory modification of the Solvay process. Mr. Smith gives 21 pages to gravimetric and colorimetric analysis, and 35 pages to physical chemistry; organic chemistry, mostly preparations, gets 55 pages and qualitative analysis 52. An appendix contains directions for the preparation of reagents and a table of logarithms. The scheme contains more experiments than can usually be done in a school course, but does not contain any on the colloidal state, or on the determination of gas-volume ratios, and few on inorganic preparations. Still, the book contains a good course of work, and the author is obviously an experienced teacher who knows the limitations of a school laboratory.

Inorganic Syntheses

Editor-in-Chief, Ludwig F. Audrieth. Vol. 3. Pp. xi+230. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 32*s*.

THIS volume continues a series intended to provide chemists with a compilation of tested methods for the synthesis of inorganic compounds. Any such series is likely to have the limitation evident in this volume—that it provides only for a restricted number of specialists in particular fields of research. The wide variety of techniques common in modern inorganic chemistry tends to bring discontinuity into any text covering selected compounds rather than chosen experimental methods.

In addition to a number of specially selected single substances, this volume covers several interesting groups of inorganic compounds such as alkali phosphates and fluo-phosphates, a number of anhydrous metal fluorides, and several organo-silicon derivatives. The special techniques required for the preparation of strontium sulphide and selenide phosphors are fully detailed, and a particularly interesting section outlines the extraction and separation of zirconium and hafnium from cyrtolite. Further sections deal with the preparation of boron trichloride and tribromide, rendered particularly difficult by the ease of hydrolysis of these compounds.

The descriptive detail of this volume maintains the high standard set by volumes 1 and 2, and the whole work gives evidence of careful selection and testing of the prescribed methods. It is a worthy addition to any reference library, although the frequency of its use will largely depend on the particular interests of inquiring readers. The book also provides useful material for a neglected aspect of university work—the teaching of preparative inorganic chemistry.

A. J. E. W.

Inland Waterways of Great Britain and Northern Ireland

Compiled by Lewis A. Edwards. Pp. xvi+440. (London: Imray, Laurie, Norie and Wilson, Ltd., 1950.) 30*s*.

THIS book contains much valuable and detailed information about the canals and rivers of Great Britain and Northern Ireland. The bulk of the text consists of an alphabetical account of each canal and river at present open to navigation, giving areas served, distances, maximum dimensions for craft using the waterway, speed regulations and other information essential to users. In addition, there is a valuable appendix containing short sections on such matters as the history of inland waterways, locks and lifts, aqueducts, bridges and types of commercial craft. There are also navigation hints, tides and tidal information and a list of rivers suitable for canoeing. Particularly useful is the glossary of canal terms, with its definitions ranging from the so-frequently misused term 'barge' to 'chalico' (the mixture used for dressing the timbers of wooden boats) and to the 'gongoozler' (an idle and inquisitive person who stands staring for long periods at anything out of the common).

In a foreword, Mr. R. F. Aickman, chairman of the Inland Waterways Association, stresses the point that the two thousand miles of navigable river and canal in Great Britain offer unlimited possibilities for pleasure traffic, and argues that what has been done on the Norfolk Broads can be done throughout the country.

Under the provisions of the Transport Act, 1947, our navigable rivers and canals have become national property, and the great interest now taken in the possibilities of using these waterways for pleasure traffic, together with the efforts of the Inland Waterways Association, is leading to considerable developments. In addition, it is clear that local water shortages, coupled with serious flooding in many areas, make the maintenance and improvement of the inland waterways of Great Britain a national necessity.

K. G. FENELON

THE DEVELOPMENT OF TAXONOMIC THEORY SINCE 1851*

By J. S. L. GILMOUR

Director, University Botanic Garden, Cambridge

THE early 1850's as a starting point for the examination of the development of taxonomic theory are appropriate not only because of the centenary aspect of the Edinburgh meeting of the British Association but also because they have an intrinsic importance as the culminating point of pre-Darwinian taxonomy, when the natural system had triumphed completely over the Linnean. What basic assumptions, then, were held by taxonomists at this period? What, to put it crudely, did men like Robert Brown and William Hooker have at the back of their minds when they described one of their countless new species, genera or families? A good answer can be obtained from John Lindley's preface to his "Natural System of Botany" (1836).

Lindley's basic concept was that of natural affinity. He looked upon classification as a process of discovering such affinity between different species, the degree of affinity being measured by the degree of resemblance. The concept of affinity itself is nowhere specifically defined; but it is clear, I think, that Lindley did not regard it as identical with degree of resemblance, but rather as something distinct which was indicated by resemblance. In so far as Lindley did attempt to characterize further the concept, he linked it with the then commonly held belief in the existence of a plan of creation laid down, once and for all, by a Creator, and he regarded affinity between species as, in some way, an expression of such a plan. He was, however, not altogether whole-hearted in his support of this view. "We must suppose," he writes, "that one plan only has been observed in the creation of living things, and that a natural system is the expression of that plan." Immediately afterwards, however, he qualifies this by adding that "it must not be forgotten that such a plan may be represented in many ways". This gave scope for his strongly held conviction that, above the rank of species, which he regarded, of course, as fixed and unchanging, taxonomic categories are man-made, and that it is quite impossible for us ever to construct one universally agreed natural classification, not only because of our varying degree of skill in the recognition of affinity but also because species are connected in, so to speak, many different planes, thus making it impossible to represent their relationship in a single, one-dimensional scheme.

We can take it that Lindley's concept of natural affinity, more or less modified, of course, as regards emphasis, was the generally accepted assumption underlying biological classification immediately before Darwin, in 1859, put forward his theory of evolution based on natural selection. Before considering the effects of Darwin's work, I would like to point out, in passing, that the natural affinity concept inevitably placed biological classification in a category quite apart from the classification of non-living things and that there was very little attempt at that time, by biologists, to consider what common principles, if any, there might be between the classification of, say, books on one hand and buttercups on the other.

As is well known, the acceptance of evolution led Darwin himself, and taxonomists in general, to give a new meaning to natural affinity. Lindley's rather vague and mystical concept was re-interpreted in evolutionary terms, and identified with what was variously described as genealogical relationship, phylogenetic relationship, true relationship, or simply relationship. Darwin himself, for example, in the famous Chapter 14 of the "Origin of Species", laid down that all true classification is genealogical and that "community of descent is the hidden book which naturalists have been unconsciously seeking", and the majority of later taxonomists have taken the same view. George Bentham, for example, in his address to the British Association in 1874, on "The Recent Progress and Present State of Systematic Botany", expounds it at length, and most modern text-books echo the same interpretation. Dr. Swingle, for example, in his "Text Book of Systematic Botany" (1946) writes: "The *ideal* classification . . . must show actual phylogenetic relationships", and many other similar expressions of this view could be quoted.

Interrupting and disturbing, however, this stream of doctrine flowing from the "Origin of Species", there have been an increasing number of rocks and islets of opinion which have criticized, in one way or another, the simple identification of Lindley's natural affinity with post-Darwinian 'relationship'. Such criticism has not, of course, been directed for one moment against either the fact that evolution has taken place, or that genealogical relationship is clearly one of the prime factors influencing similarity between living organisms. The criticism, rather, has been directed against the over-facile picture that has been built up of the existence of one single, vast, phylogenetic tree of living organisms, analogous with a genealogical family tree of individuals, and against the view that the prime and ultimate aim of taxonomy is to discover and embody this tree in one ideal system of biological classification. Many botanists and zoologists have shared in this critical attack; but I have space to mention only F. A. Bather's masterly analysis in his address to the Geological Society of London in 1927 on "Biological Classification, Past and Future", and W. B. Turrill's comprehensive survey in *The Botanical Review* of 1942. Further, those who took part in the Systematic Association's discussions just before the War on this subject will not easily forget the arguments put forward on both sides, nor the heat they engendered, and this year at Leeds the battle was joined again under the auspices of the same Association (see *Nature*, **167**, 503; 1951).

What, then, has been the substance of these criticisms? Broadly speaking, they have emphasized the extreme complexity of evolutionary change, the impossibility of extracting from the welter of actual evolutionary history (including polyphyletic origins in both time and space) any single, simple factor that can be called genealogical or phylogenetic relation-

* Substance of a paper read on August 14 before Section K (Botany) of the British Association meeting at Edinburgh.

ship, and the folly, even if such a factor could be isolated, of regarding morphological resemblance as an exact index of it.

There is no doubt, to my mind, that such criticism is amply justified, but I would like to suggest that it has somewhat misfired owing to the lack of any positive proposal put forward as an alternative to the admittedly very attractive and simple picture of one ideal classification based on "true relationship".

To understand the reason for this lack of alternative we must go back, for a moment, to Lindley and the pre-Darwinian taxonomists. Their concept of natural affinity, expressing the plan of a Creator, lifted biological classification right out of the realm of the classification of non-living things, and the Darwinian re-interpretation has, of course, further emphasized this separation. The fact is, however, that biologists have almost completely ignored, or dismissed as irrelevant, the fundamental principles of classification which apply to all objects, whether living or non-living, and which have been discussed and re-discussed by philosophers from the time of the Greeks until the present day. This isolation of biological from general classification has, in my view, been fatal to a proper appreciation of the aims and methods of taxonomy and is largely responsible for the confusion that exists to-day.

These general principles may be studied in many text-books of philosophy and scientific method. Perhaps the most satisfactory for our purpose is "The Principles of Science" by W. S. Jevons, first published in 1874. From this and other sources the following highly simplified elementary principles may be extracted.

(1) Classification is a fundamental prerequisite of all conceptual thought, whatever the subject material of that thought. Thus, as soon as we call an object 'hot', we are creating a class of hot things and assigning the object to that class.

(2) The primary function of classification is to construct classes about which we can make inductive generalizations. Thus, having constructed the class of hot things, we construct a further class of 'things that hurt', and, based on experience, we can make the inductive generalization that hot things hurt.

(3) The particular classes we construct always arise in connexion with a particular purpose. The class of 'things that hurt' clearly springs from a universally important purpose to human beings—the avoidance of suffering; the class of, say, "botanists whose fathers had beards", does not, and hence has not, so far as I know, been constructed before this moment.

(4) The classification that we adopt for any set of objects depends on the particular field in which we wish to make inductive generalizations. Different fields of generalization call for different classifications. Thus, if we wish to investigate the connexion between female authorship and murder stories we would make quite a different classification of books from that required for generalizations about, say, American publishers and limited editions.

(5) Clearly some classifications are of more general use than others. Thus a classification of books, based on subject-matter, into such classes as dictionaries, novels, biographies, etc., is of wider use than one based on the colours of bindings. The reason for this is that the basis of the first classification, namely, the contents of the book as conceived by the author, affects more of its characteristics than does the basis of the second classification, namely, the colour of the book as conceived by, presumably, the publisher. In short, subject-matter has a stronger influence on the total characteristics of books than has binding design. In the general theory of classification, classifications which serve a large number of purposes are called natural, while those serving a more limited number of purposes are termed artificial.

(6) It is clear from the above that there cannot be one ideal and absolute scheme of classification for any particular set of objects, but that there must always be a number of classifications, differing in their basis according to the purpose for which they have been constructed. One classification may, of course, be more natural than another in the sense defined above, and if there is one factor influencing a group of objects more powerfully than any other, then a classification based on that factor will be more natural—that is to say, useful for a greater number of generalizations—than any other; but the difference between this and other classifications is one of degree only, and not of kind. In the classification of books, for example, an arrangement based on subject-matter is probably more natural than any other, but one based on authorship must run it fairly close, bringing in, as it does, the factors of date and style, as well as, to some extent, that of subject-matter.

The view just outlined of the general nature and function of classification as a basic process in the making of inductive generalizations is the one generally accepted by students of scientific method. What is its relevance to biological classification? Its relevance is, I suggest, two-fold. In the first place, it can perhaps help us to understand more clearly the history of taxonomy, its aims and its methods, during the past hundred years; and, secondly, it can, I think, lead to a view of the aims of taxonomy more in line than at present with modern philosophical thought in general and more useful in solving some of the problems now confronting taxonomists—notably those problems concerned with the incorporation of recent data from experimental taxonomy into suitable taxonomic categories.

As regards history, we can see how a failure to appreciate the general principles of classification, and to apply them to living things, has led biologists to seek other aims for taxonomy in order to fill the vacuum created. The form which these aims have taken, namely, the construction of one ideal classification based, at first, on natural affinity and, later, on 'true relationship', is a particularly attractive one to the human mind. It has the comforting qualities of all 'absolutes', and the concept of true relationship undoubtedly bears, emotionally, a strong family resemblance to the concepts of beauty in æsthetics and goodness in ethics. Recently there has been a widespread element in philosophical thought tending to examine critically these absolute concepts in æsthetics and ethics, and I suggest that the time has come for the same healthy breeze to be directed towards the concept of true relationship in taxonomy.

This brings us to our second point of relevance. Let us suppose, for a moment, that we have abandoned as chimærical the aim of constructing one ideal classification of living things based on true relationship. What aim, grounded in the general principles of classification, can we put in its place, and how would such an aim help us to solve present problems in taxonomic practice?

Clearly, the primary aim of taxonomy, on this basis, must be the construction of classes of living things about which scientifically useful inductive generalizations can be made. Further, there must

be a number of different classifications, each based on different characters, and each equally valid for its own purpose.

It is true that there will be one, as it were, general-purpose classification, more natural than others, in the sense that more inductive generalizations can be made about its classes—and this general-purpose classification is, of course, the normal taxonomic arrangement into species, genera, families and so on. This classification should not, however, be regarded as an approximation towards a single, ideal scheme, but as a permanently flexible arrangement, changing as new knowledge is acquired and incorporated in it. It can be called phylogenetic only in a secondary sense, namely, that the reason why a particularly natural biological classification can be made at all is of living things—and, further, phylogenetic studies can, of course, be made regarding the origin and development of its groups; but both these considerations are very different from regarding a natural classification as essentially and primarily phylogenetic.

One may well ask, what difference does it make in practice whether we regard a natural classification of living things as—to put it briefly—'logically' natural or 'phylogenetically' natural. Are we not just splitting hairs, with no practical result? I do not believe that this will prove to be the case. I believe it is possible that, if we can once and for all lay the bogey of the existence of true relationship and realize that there are, not one, but many kinds of relationship—genealogical relationship, morphological relationship, cytological relationship, and so on—we shall release ourselves from the bondage of the absolute in taxonomy and gain enormously in flexibility and adaptability in taxonomic practice. Instead of the present rigid separation between the normal categories on one hand and those of experimental taxonomy on the other, we shall realize that they differ in degree and purpose only, and are all equally valid for the overall purpose of making inductive generalizations about living things. To take a concrete example, Turesson's genecological classification and its later modifications, or Danser's categories of *Comparium*, *Convivium*, etc., based on capacity to interbreed, should not be regarded as possible rivals of the orthodox categories, but as special classifications equally valid for their own particular purposes. In the same way, a truly phylogenetic classification, based on known lineages, would also take its place as a special classification constructed for its own particular purpose.

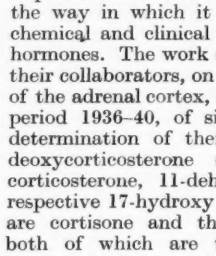
An ever-increasing volume of data is now being produced in the field of experimental taxonomy, data showing the great complexity of the units comprising the ebb and flow of evolutionary change. Recently, Dr. W. H. Camp, in a stimulating paper entitled "Biosystematy" (*Brittonia*, **7**, 113; 1951), has emphasized forcibly the difficulty of fitting the dynamic concepts of modern experimental taxonomy into the orthodox categories of genus and species, conceived, as they were, against the static background of special creation. He hints that these categories may have to be abandoned completely for the special purpose of classifying the actual units of evolutionary change, and I would strongly support this view. Such a course would seem almost sacrilegious if we regard the orthodox taxonomic categories as an attempt at expressing 'true relationship'; but on the view that I have been outlining, that they are human contrivances constructed for human purposes, there is, of course, nothing shocking in abandoning them if they do not serve the particular purpose we have in mind at the moment.

I do not claim that what I have said here is more than the outline of an approach to present taxonomic problems, and I hope that others may be persuaded to join in working out its implications more fully.

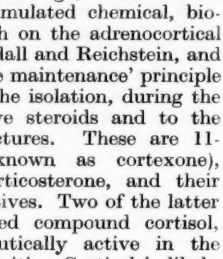
ORGANIC CHEMISTRY IN THE SERVICE OF MEDICINE

ONE of the sessions of Section B (Chemistry) of the British Association, during the recent Edinburgh meeting, was devoted to a symposium on "Organic Chemistry in the Service of Medicine." Notwithstanding the title, two of the three papers which were presented had a distinctly biochemical flavour, which perhaps serves to emphasize that organic chemistry and biochemistry are inextricably intermingled, in spite of those who would have it otherwise. The chair was taken by Prof. G. F. Marrian, who suggested that one of the main reasons for the selection of the subject of the discussion was a desire to honour the memory of the late Prof. George Barger, his predecessor in the chair of chemistry in relation to medicine in the University of Edinburgh. Prof. Marrian recalled some of Barger's outstanding chemical contributions to medical science, and referred also to the important work carried out by some of the pupils whom he inspired.

The first paper in the symposium was read from the chair by Prof. Marrian, who described recent work on the adrenocortical steroids. He pointed out that the discovery by Hench, Kendall and their collaborators of the treatment of rheumatoid arthritis and certain related diseases by cortisone, or by administration of the adrenocortical stimulating hormone of the anterior pituitary, no longer seems to be the great discovery in practical therapeutics that at first it appeared to be. But to the medical scientist, who takes a longer view than his clinical colleague, the discovery appears to be even more important than it did two years ago, on account of the way in which it has stimulated chemical, biochemical and clinical research on the adrenocortical hormones. The work of Kendall and Reichstein, and their collaborators, on the 'life maintenance' principle of the adrenal cortex, led to the isolation, during the period 1936–40, of six active steroids and to the determination of their structures. These are 11-deoxycorticosterone (now known as cortexone), corticosterone, 11-dehydrocorticosterone, and their respective 17-hydroxy derivatives. Two of the latter are cortisone and the related compound cortisol, both of which are therapeutically active in the treatment of rheumatoid arthritis. Cortisol is likely



Cortisone
(17-Hydroxy-11-dehydro-corticosterone)



Cortisol
(17-Hydroxy-corticosterone)

soon to be more readily available, and is believed to be preferable to cortisone in some respects.

Cortisone appears to influence rheumatoid arthritis and related diseases by suppressing the inflammatory symptoms in the mesenchymal tissues; this is in contrast with the function of adrenocortical hormones in the treatment of Addison's disease, where the effect is to make good a deficiency or absence of the endogenous hormones.

Prof. Marrian thought that, from a biochemical point of view, one of the most interesting and challenging facts about the adrenocortical hormones is the multiplicity of the physiological and pharmacological effects which they are able to produce. He suggested that there may be some common biochemical factor underlying these, possibly the interaction of the hormone with some particular chemical grouping which is present in a number of different enzymes. Several groups of workers have demonstrated effects *in vitro* of some of the hormones on the carbohydrate metabolism of preparations of liver and muscle tissue. It has also been found that granulation tissue from healing wounds or embryonic tissues maintained *in vitro* are able to fix sulphate in insoluble organic combination, possibly due to the synthesis of sulphated mucopolysaccharides. This fixation of sulphate can be entirely inhibited by the addition of cortisone to the culture medium. Another group of workers has found that hyaluronidase can be inhibited by cortisone.

One of the most outstanding recent achievements has been that of Pincus and his collaborators, who have shown conclusively, by using cholesterol labelled at C_3 with carbon-14, that under the influence of adrenotrophic hormone the adrenal gland is able to manufacture the adrenocortical hormones by degradation of cholesterol. By using various steroids these workers were also able to show that the gland (without adrenotrophic hormone) can effect hydroxylation at positions 11, 17, and 21, and they obtained evidence that progesterone is an intermediate in the conversion of cholesterol to the adrenocortical hormones. Thus progesterone, which has been isolated from the adrenal gland, was converted into corticosterone and cortisol.

In conclusion, Prof. Marrian referred to current work aimed at the total synthesis of cortisone, which may conceivably satisfy the requirements of the hormone for clinical use. He recalled the recently announced total synthesis of *epi*androsterone by Sir Robert Robinson and his collaborators, an achievement which also represents the total synthesis of androsterone and testosterone. Almost simultaneously, Woodward and his collaborators announced the total synthesis of the methyl ester of *dl*-3-keto-$\Delta^{4,9(11),16}$-*aetio*cholatrienic acid. This has since been resolved and converted into cholestan-3β-ol, which had already been converted into cholesterol. Among other steroids the total synthesis of which has been completed by this work is the adrenocortical hormone cortexone (the total synthesis of cortisone has also just been reported (Woodward *et al.*, *J. Amer. Chem. Soc.*, **73**, 4057; 1951)).

Dr. F. L. Rose followed with an interesting and authoritative account of the extensive co-operative researches carried out during the Second World War on the synthesis of new antimalarial drugs. The most outstanding advances in this field were those of Dr. Rose himself and the late Dr. F. H. Curd and their collaborators, culminating in the discovery of the most effective antimalarial drug so far known, namely, 'Paludrine'. The importance of this service to medicine and to mankind may be gauged by Prof. Marrian's comment that it has been estimated that a quarter of the population of the world suffers from malaria. In his contribution, Dr. Rose pointed out that malaria is unique among the diseases of micro-organismal origin in that it has a history of chemotherapy extending over the past three hundred years, arising from the use of the cinchona alkaloids. Quinine is not the perfect antimalarial drug, however, and the search for improved synthetic agents began in the past century. Dr. Rose showed how the observation by Ehrlich and Guttman in 1891 of the slight therapeutic effect in man of methylene blue opened the way for future developments. Exploitation of this early lead was delayed until new preparations, based on this dyestuff, could be assayed in the laboratory. This came in the early part of the present century with the discovery and use of the avian malarias. By then, the significant features of the structure of quinine had become clear, and this knowledge led in 1926 to the synthesis in Germany of the related 6-methoxyquinoline derivative pamaquin (originally called 'Plasmoquine'). The continued search for a drug having schizonticidal activity resulted, a few years later, in the acridine derivative mepacrine ('Atebrin'), and it was this substance that was selected for process study in Britain in 1938 as an insurance against a break in quinine supplies resulting from war, which then seemed imminent. At that time, the use of mepacrine was still in the experimental stage, and although its availability from 1940 onwards was of vital military significance, careful clinical investigations established its limitations and disadvantages. As a result, intensive co-operative searches for new and improved agents were begun, co-ordinated in Great Britain by the Medical Research Council, and in the United States by the National Research Council. The objectives were freedom from colour (skin pigmentation) and reduced toxicity, ease of manufacture, and an action at the exoerythrocytic phase of the life-cycle of the causative parasite. This last had by the early 1940's assumed paramount importance in the minds of workers looking for new antimalarial drugs, since only through the control of the tissue forms could true causal prophylaxis be obtained.

A vast screening programme in the United States dealt with some fourteen thousand compounds, and led to the discovery of antimalarial activity in experimental infections (including prophylactic action) in a number of previously unconsidered chemical types. The most important outcome of this search was the establishing of the therapeutic value of the 4-aminoquinoline derivative chloroquin, a substance which under its name 'Resochin' is now known to have been undergoing field-trials at the hands of its German discoverers in 1939.

In Britain, a more modest programme led to the preparation and assay of, perhaps, two thousand substances in all. The majority of these were based on the discovery, early in the work, of laboratory activity in a chloroanilinopyrimidine. Exploitation of this lead also resulted in the elaboration of a wide variety of compounds, mostly heterocyclic, exhibiting similar behaviour, of which one at least, *p*-chlorophenylguanidinopyrimidine, was active clinically. An attempt to get away from the use of heterocyclic systems, while yet retaining other features considered structurally significant, led in 1944 to an investigation of certain diguanide derivatives. These

proved active, not only against erythrocytic but also against the exoerythrocytic forms of the experimental avian parasites, and one such derivative, proguanil ('Paludrine': N^1-*p*-chlorophenyl-N^5-*iso*propyldiguanide), has passed into extensive clinical use on this basis.

As a result of these war-time endeavours, the objectives initially postulated have been largely attained. The causative organisms of malaria are so numerous in variety and drug susceptibility, however, that some forms of the disease inevitably remain resistant to therapy if only in degree, and the existence of these, together with the problem of relapse in certain cases, provide the challenge for the future.

In the concluding paper of the session, Mrs. R. V. Pitt-Rivers described recent work on the thyroid gland. She pointed out that the biosynthesis of thyroxine depends on the ability of the thyroid gland to collect iodide from the plasma and to fix it in organic combination. In the normal animal, the iodine-concentrating mechanism is largely controlled by the thyrotrophic hormone of the anterior pituitary, and fails in hypophysectomized animals. Thiocyanate inhibits the iodine-concentrating mechanism and, in fact, causes the discharge of iodide already collected by the gland. The second function of the thyroid, the synthesis of thyroxine, is generally assumed to occur in three stages: (*a*) oxidation of iodide to iodine, (*b*) iodination of tyrosine, and (*c*) coupling of two molecules of diiodotyrosine. The first stage requires enzymic activity, but this is not necessarily so for the coupling reaction, as coupling can occur *in vitro* in the absence of any enzyme system. Dr. Pitt-Rivers has found that if the amino group is protected by acylation and the carboxyl group by peptide combination, then the yield of thyroxine formed by incubating diiodotyrosine aerobically can be raised to 35 per cent. The coupling is an oxidative one, but its mechanism is not known, nor is the fate of the three-carbon chain which is lost from one molecule of diiodotyrosine.

Dr. Pitt-Rivers outlined experiments with antithyroid drugs of the thiourea group and also with aniline derivatives which include *p*-aminobenzoic acid and some of the sulphonamides; these have led her to conclude that the formation of thyroxine from diiodotyrosine is an oxidative reaction brought about *in vitro* by small amounts of iodine liberated from the diiodotyrosine. In *in vivo* experiments, too, the formation of thyroxine is invariably accompanied by loss of iodine from diiodotyrosine. The remarkable inhibition of thyroid function by iodide is possibly due to an inhibition by excess of iodide of the enzyme system which is responsible for its own oxidation.

Finally, Dr. Pitt-Rivers showed how the use of new techniques, in particular the use of radioactive iodine and partition chromatography, has enabled several groups of workers to localize reactions in which iodine plays a part, and to detect iodo compounds which are present in the gland only in traces. Apart from diiodotyrosine and thyroxine, the only iodine compound present in the gland which has been unequivocally characterized is monoiodotyrosine. All three compounds are present in the thyroid in very small amount as free amino-acids, and three new iodine-containing compounds of unknown constitution have been detected in the gland. Evidence has been provided that the circulating hormone in the plasma is free thyroxine.

AUTOMATIC CONTROL

A CONFERENCE organized by the Department of Scientific and Industrial Research, on the subject of developments in the field of automatic control, was held at the College of Aeronautics, Cranfield, during July 16–21, under the presidency of Sir Ben Lockspeiser. It was attended by some three hundred engineers, mathematicians and teachers of engineering, including members from most of the leading industrial countries.

The purpose of the present article is to give an impression of the state of developments in the field of automatic control as revealed by the papers and the discussion at the conference. The broad principles of automatic control involving feed-back are now very well known, and many useful methods for the analysis of the behaviour of control systems are quite familiar. The conference was concerned with those aspects of the subject that go beyond these well-established principles and methods and in which further progress is required. The chief topics may, perhaps, be broadly classified as follows: first, educational problems arising from the growing importance of feed-back systems, and the rapid increase in the demand for personnel having specialized knowledge and skills in this field at all technical levels; second, the development and co-ordination of improved methods of mathematical analysis for such systems; third, the extension of the methods to a widening range of technical and other problems; and finally, the attempt to deal more adequately with such problems as systems with non-linearities and with intermittent data. In attempting to give a summary of the present state of progress as revealed by the conference, it will be convenient to consider these four topics in turn.

Educational problems. New requirements in respect of instruction in the principles of automatic control are arising over the whole educational spectrum, from the shortage of instrument mechanics in the chemical industries to the need for more men of the highest engineering and mathematical competence to carry on development work in such fields as the control of aircraft or the development of combined analogue-digital calculators.

The opening paper of the conference by Prof. Gordon Brown, of the Massachusetts Institute of Technology, made a striking plea for the recognition of the "feed-back engineer" as a new professional category corresponding with a new type and perhaps a new standard of professional competence. The specification for a feed-back engineer is for a man capable of synthesizing many technical specialisms and capable of eliciting co-operation at all technical levels. Prof. Brown described the postgraduate school in control engineering at the Massachusetts Institute of Technology, which has an annual output of approximately fifty postgraduate students. This figure was referred to by a member from a leading American instrument firm as "merely a drop in the ocean of America's requirements". Prof. Brown described how students are trained at the Massachusetts Institute as working engineers participating in large-scale research projects, accepted by the Institute on contract. Such forms of advanced technical training are unknown in Great Britain, where it is noteworthy that the research establishments of government departments and of the research associations have no specific educational functions and not even in organized liaison with higher education.

Progress in methods of mathematical analysis. The analysis of the behaviour of linear systems with feed-back corresponds with the discussion of the implications of a set of simultaneous linear differential equations. Since complex as well as real roots are in question this naturally leads to representation on the complex plane. The types of analysis that have been developed for application to feed-back amplifiers, networks and filters are generally applicable to linear automatic control systems. Developments now being made in this type of analysis, as indicated by one group of papers presented at the conference, may be described as the exploration of the geometry of poles, zeros and 'transfer loci' on the complex plane, in the attempt to obtain various kinds of information about the behaviour of the system, such as its modes, their kind and degree of damping, and the conformity with various criteria of stability and minimum error. A particularly interesting development arises from the fact that the functions involved are usually regular functions, and such functions of a complex variable have a correspondence with the flow-lines and equipotentials for current flow in a conducting sheet. This fact has been ingeniously exploited by A. R. Boothroyd and J. H. Westcott, who described and demonstrated the use of the electrolytic tank as an analogue interpreting a logarithmic transformation of a complex variable, by the use of which the design of both control systems and filters may be facilitated.

An important problem requiring distinct treatment arises when control systems are subject to random disturbances. Two papers, respectively by M. J. Pélégrin and S. Jones, dealt with the application to control systems of the method based on statistical ideas and correlation that was originally developed by Wiener.

The view was expressed by several contributors that, important as these improvements in analysis may be, they must, by their nature, be deficient in meeting the basic problem of the selection and design of control elements, because they do not bring under consideration the physical limitations of the elements that are essentially related to power handling and the interchange and flow of power. One paper only grappled with this problem of relating the design of machine elements to the specified power amplification and the limitations of rating. This was the paper by J. M. Layton, in which some useful first steps are taken in this direction, by introducing the relationship that arises between the time constants and the power amplification in any element (such as an electric generator) in which there is energy storage proportional to the power output.

Extension of control system theory to a wider range of problems. One of the most important and rapidly expanding fields for the application of automatic regulation and control is the chemical and process industries. A complete day of the conference was devoted to this field. This was deliberately placed in the middle of the conference programme, because the organizers thought that one of the needs of the moment is to throw 'process engineers' and 'servo engineers' into intimate contact. This plan resulted in a vigorous discussion, somewhat hampered by difficulties of language, and by the unfortunate fact that each party appears to the other to plot all its diagrams back to front and for the inverse variable. It may be unfortunate that those now attempting to establish standardization of terms have abandoned the effort to reconcile those of process engineering with those of 'servos', and propose to perpetuate the differences. Perhaps a few years of delay and more such joint meetings would convince both parties that a common nomenclature would be both possible and useful.

The papers presented under the general heading of process control dealt mainly with the calculation and measurement of the transfer functions of pneumatic controllers and of plant elements such as pipe-lines and heat exchangers, in a form that permits of the use of this information in the familiar 'frequency-response' type of analysis.

Automatic-control principles are constantly finding application in new and somewhat surprising contexts. For example, A. Garde, of Stockholm, described an experimental investigation of the response of frequency to power load for a complete power system that involved the artificial imposition of a sinusoidal variation of power of 15 MW. as the test signal.

The theory of control systems is mainly a discussion of systems in which a number of variables, often a large number, are interdependent or inter-related, that is, some of the sequences of dependence are closed. This situation arises in many scientific fields, and when it is required to discuss the behaviour of such systems the methods of the theory of control systems may be useful. A good example is in economics, where much recent work concerns the implications of given inter-relationships between 'macro-economic' variables such as total income and total investment. This topic was the subject of an informal evening lecture given by J. R. N. Stone, of Cambridge, with a short addendum from an engineer's point of view by Prof. A. Tustin. It was urged that the interpretation of the implications of the rather complex 'models' necessary to give adequate representation of an economic system might be assisted by the use of physical analogues, as is often done in the case of complex engineering problems.

Special problems: intermittent data and non-linear systems. Groups of papers were devoted to the two chief aspects of control system analysis which the usual linear theory omits.

The first type of problem is that in which the system may be linear in the sense that it satisfies the principle of superposition, but where the operation is essentially discontinuous. One familiar example arises when 'clamped' or 'chopper bar' regulators are used, that measure a continuous variable at fixed equi-spaced instants, but between these instants merely hold or 'clamp' the value from the preceding measuring instant. A very analogous problem arises when incoming data is in digital form, giving effectively the value of a set of equi-spaced ordinates of the input curve. The handling of such problems will be greatly facilitated by papers included in this conference. The contributions by Prof. C. Holt-Smith, D. Lawden and A. E. Bailey, and the papers by Dr. R. C. Oldenbourg and Dr. H. Sartorius from Germany, make a noteworthy advance on previous work.

One day of the conference was given to the different problems that arise when systems are non-linear. Among those present for this discussion were such well-known authorities as Prof. B. van der Pol, Dr. N. Minorsky and Dr. Mary L. Cartwright, and the discussion was on a high level even if it mainly showed once more the unfruitfulness, so far, of attempts to deal with most non-linear systems except to seek specific numerical solutions to specific problems. A possible point for future progress lay in the paper by C. Cherry, in which he returned to

fundamentals, and showed by adapting the equations of Lagrange that in certain systems the part played by energy in linear systems is played by areas under a curve in the case of non-linear systems.

Manual control as distinct from automatic control was not forgotten. The paper on this subject by J. D. North included a thorough analysis of a 'model' that may provide a useful approximation for the response of hand to eye in some simple situations such as target tracking or car driving.

The discussions throughout the conference were vigorous and sustained. It appeared to be the opinion of all who attended that the conference has helped to lay foundations on which much further progress may now be based.

The papers presented, together with selected material from the discussions during the conference, will be published in due course as a single volume by Butterworths Scientific Publications, Ltd.

A. TUSTIN

STRUCTURE OF RIBONUCLEIC ACID

By DR. ROY MARKHAM and DR. J. D. SMITH

Agricultural Research Council Plant Virus Research Unit, Molteno Institute, University of Cambridge

IN the past few years the basic constitution of several ribonucleic acids has been established[1–4], but so far there has been little evidence as to the way in which the constituent nucleotides are arranged in the molecules. Hydrolysis of ribonucleic acids by alkali and by cold dilute acids gives rise to isomeric nucleotides which are probably 2′ and 3′ nucleoside phosphates[5–7], and Cohn and Volkin[8] have recently also identified 5′ nucleoside phosphates in ribonucleic acids digested successively with both ribonuclease and alkaline phosphatase. In the work which we propose to describe, we have attempted to isolate the larger fragments produced by ribonuclease action, and we have succeeded in establishing the structure of certain of the dinucleotides which were formed.

Anhydrides of the Pyrimidine Nucleotides

In our investigation of the products of digestion of ribonucleic acids, our attention was drawn at once to the presence of two substances which we have called *C* and *U* [9]. These substances are digested slowly by ribonuclease to give free cytidylic and uridylic acids respectively, and each contains one atom of phosphorus per pyrimidine residue. They differ from the nucleotides in that they have higher R_F values in 70 per cent v/v *iso*propanol–water–ammonia (solvent *a*), and lower R_F values in 80 per cent saturated ammonium sulphate in water, 2 per cent *iso*propanol, 18 per cent *M* sodium acetate (v/v/v) (solvent *b*). These properties led us to believe that they contained less free hydrophylic groups than exist in the corresponding nucleotides, possibly because they were dinucleotides or dinucleoside pyrophosphates. When we were doing this work, we were fortunate in having a discussion with Prof. A. R. Todd and Dr. D. M. Brown, and they were kind enough to disclose their theory of the formation of the isomeric nucleotides of Carter and Cohn. This theory[7] necessitates the existence as intermediates during the chemical hydrolysis of ribonucleic acids of cyclic anhydrides of the nucleotides, which have the phosphoric acid residue esterifying the ribose at positions 2′ and 3′. Such substances would have the properties of our *C* and *U*, and, in addition, would have the same electrophoretic mobilities as the corresponding nucleotides at *p*H 3·5, as do *C* and *U*, while, as we will show, the electrophoretic mobility of a dinucleotide should be about 1·54 times that of a mononucleotide having the same constituents. Synthetic samples of the anhydrides of cytidylic and uridylic acids prepared by Mr. D. Magrath were chromatographed by us in several solvent systems and could not be distinguished from *C* and *U* in any of these, while they too were digested slowly by ribonuclease to give the free nucleotides. It seems very likely that *C* and *U* are the 2′, 3′ anhydrides of cytidylic and uridylic acids respectively. The analogous adenine derivative was not digested by ribonuclease, and it seems probable that the guanine derivative is also resistant to digestion.

Free Nucleotides and Polynucleotides

For preparing these substances we have digested purified yeast ribonucleic acids with ribonuclease in dialysis sacs at 20° and also at 4° with stirring, so that any fragments liberated should have a chance to escape further digestion. After concentration *in vacuo*, the dialysate has been chromatographed in solvent *a* on Whatman No. 3 paper in bands. The developed chromatograph shows a residue at the top (band 0) and six main bands numbered 1–6 in order of their R_F values. Band 6 contains *C* and *U* only. Bands 1, 2 and 3 contain compounds of all four bases, while bands 4 and 5 have no guanine derivatives. Band 4 contains only adenylic acids *a* and *b*, cytidylic and uridylic acids. Free guanylic acids *a* and *b* are found in band 2. Bands 3 and 5 contain substances having properties similar to *C* and *U*; that is, they are digested by ribonuclease to give substances running faster in solvent *b* and slower in solvent *a*, but without changing their gross analytical composition. The analyses, however, show that each band contains several substances, as the purine and pyrimidine bases are not present in simple proportions.

Electrophoretic Separation

After trying without success a number of solvent systems for separating the substances in each band, we decided to try electrophoresis on filter paper strips, immersing the wet filter paper in carbon tetrachloride to cool it and to prevent evaporation. Strips of Whatman No. 3 paper 56 cm. long and 8 cm. wide were used, and the material was applied about 12 cm. from one end. A voltage gradient of 20–25 V./cm. was used and the average run was two hours (Fig. 1).

Before attempting the separation, we calculated the probable relative electrophoretic mobilities of all mono-, di-, and some tri-nucleotides at several *p*H values, using the dissociation constants of Levene and Simms[10], assuming that the mobilities were proportional to the net charge on the molecule, and inversely proportional to the cube root of the molecular volumes, a relationship which should hold to a close approximation in the case of such asymmetrical molecules, and which has been found to hold with some minor deviations in practice. The

CALCULATED ELECTROPHORETIC MOBILITIES TOWARDS THE POSITIVE ELECTRODE OF ALL THE MONO- AND DI-NUCLEOTIDES AND SOME OF THE TRI-NUCLEOTIDES AT *p*H 3·5, RELATIVE TO THAT OF URIDYLIC ACID. The symbols *A*, *G*, *C* and *U* signify the presence in the compound of one residue of adenylic, guanylic, cytidylic and uridylic acid respectively. The order in which they appear is not significant.

Mononucleotides		Dinucleotides		Trinucleotides	
C	0·16	*CC*	0·25	*ACC*	0·54
A	0·46	*AC*	0·48	*AAC*	0·75
G	0·95	*AA*	0·71	*GCC*	0·88
U	1·00	*GC*	0·85	*ACG*	1·09
		CU	0·89	*ACU*	1·13
		AG	1·08	*AAG*	1·30
		AU	1·13	*AAU*	1·33
		GG	1·46	*AGG*	1·64
		GU	1·50	*GCU*	1·67
		UU	1·54	*AUU*	1·71

order of movement that we calculated for *p*H 3·5 (*M*/20 ammonium formate buffer)—the value which we selected as optimum for our purposes—is shown in the accompanying table. At this *p*H the mobility is decided entirely by the primary phosphoric acid —OH⁻ groups and the —NH_3^+ groups of the bases, and therefore anhydrides of the type of *C* and *U* and their derivatives will move at approximately the same speed as the corresponding nucleotides and their derivatives.

On electrophoresis, bands 1, 2, 3 and 5 are each found to contain at least three or four major constituents, most of which have been identified provisionally, while several of these substances have been submitted to analysis and have been found to have simple compositions. Among the latter are the dinucleotides of adenine and guanine, adenine and cytosine, guanine and uracil, and guanine and cytosine. These substances are found in bands 1 and 2 and are not attacked by ribonuclease; but there are also substances having the same composition with regard to the bases as the last three of these dinucleotides, but occurring in bands 3 and 5. The latter are digested by ribonuclease to give the dinucleotides only. As an example of this we can take the guanine–uracil dinucleotide of band 1. This substance can be isolated in a pure state from band 1 by electrophoresis, and is the fastest moving component of this band, having a *gross* mobility of $1{\cdot}1 \times 10^{-4}$ cm.² sec.⁻¹ volt⁻¹. In band 3 there is a substance which also has one equivalent of guanine to one of uracil and has a mobility of $1{\cdot}3 \times 10^{-4}$ cm.² sec.⁻¹ volt⁻¹ (this difference is not significant). The substance from band 3 is converted into the dinucleotide of band 1 slowly by ribonuclease digestion. This digestion is not splitting a tetranucleotide, as such a compound would have a mobility of about 2×10^{-4} cm.² sec.⁻¹ volt⁻¹, nor, of course, is any phosphorus liberated. Similarly, the adenine–cytosine dinucleotide of band 5 is converted by ribonuclease to that in band 2, as is the adenine–uracil dinucleotide of band 5; and all these digestions also cause the resulting dinucleotides to have higher R_F values in solvent *b*.

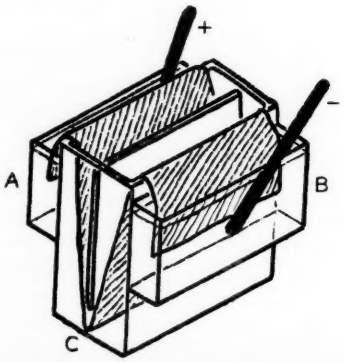


Fig. 1. Electrophoresis apparatus. Vessels *A* and *B* contain the buffer solution. Vessel *C* contains carbon tetrachloride, and in use is covered with a piece of plate glass. The wet paper is spaced in vessel *C* by a piece of celluloid. The electrodes are arc carbons

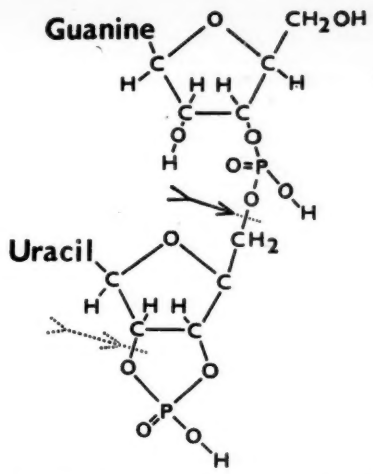


Fig. 2. Probable structure of the guanine–uracil dinucleotide anhydride. The arrows show the alkali labile bonds, while the dotted arrow indicates the bond which is also broken by ribonuclease

Now these properties parallel exactly the behaviour of the pyrimidine nucleotide 2′, 3′ anhydrides, so it would seem that the dinucleotides of bands 3 and 5 contain the latter joined at position 5′ as one half of the molecule.

The purine nucleotides derived from these dinucleotides by alkaline hydrolysis are of the 2′ and 3′ types and the dinucleotides do not react with periodate, so that the internucleotide link must be of the 3′ (or 2′), 5′ type. The only likely formula for the guanine–uracil dinucleotide anhydride is given in Fig. 2 (it being understood that at the moment it is not possible to distinguish between a 2′ and a 3′ nucleotide residue in such a compound, as hydrolysis invariably results in the formation of roughly equal amounts of the 2′ and 3′ nucleotides).

Discussion

It will be seen from these results that a large number of the internucleotide linkages in yeast ribonucleic acid are of the 3′ (or 2′), 5′ type and also that some at least of the alkali labile bonds of ribonucleic acid are situated at the 5′ sugar carbon atoms. From this it would appear that the linkages broken by ribonuclease are similar to those broken by alkali, with the important exception that ribonuclease distinguishes between purine and pyrimidine nucleotides. We have found that, by cautious alkaline hydrolysis of ribonucleic acids, using barium carbonate at 100°, corresponding to a *p*H of just over 9, the anhydrides of the pyrimidine nucleotides are released, showing the analogy of the action of alkali and ribonuclease.

The general nature of the products of ribonuclease digestion suggests that, as in alkaline hydrolysis, it

is necessary for a cyclic intermediate to exist, and that this intermediate must also be a pyrimidine nucleotide derivative. This would explain the rapid formation of the large amounts of the anhydrides *C* and *U*, as they would be chopped out of the ribonucleic acid wherever two or more adjacent pyrimidine nucleotides having either a free 2′ or 3′ —OH group were to be found in the molecule. The existence in the digests of the free 2′- and 3′-guanylic and adenylic acids is difficult to account for by this theory, unless they were joined to pyrimidine nucleotides by a 2′, 3′ link (or the equivalent), as this link would allow the formation of the intermediate anhydride.

A study of the trinucleotides of band 1 and the larger products of ribonuclease digestion is now being made in an attempt to confirm this theory, and we are also hoping to be able to make quantitative estimates of the amount of the various constituents on the well-characterized and undegraded turnip yellow mosaic virus nucleic acid[4].

It is a pleasure to thank Prof. D. Keilin and Dr. K. M. Smith for their interest in this work. We are also greatly indebted to Prof. A. R. Todd and his colleagues, notably Drs. Brown and Dekker, for discussing problems of mutual interest.

[August 7.

[1] Chargaff, E., Magasanik, B., Vischer, E., Green, C., Doniger, R., and Elson, D., *J. Biol. Chem.*, **186**, 51 (1950).
[2] Smith, J. D., and Markham, R., *Biochem. J.*, **46**, 509 (1950).
[3] Markham, R., and Smith, J. D., *Biochem. J.*, **46**, 513 (1950).
[4] Markham, R., and Smith, J. D., *Biochem. J.*, **49**, 401 (1951a).
[5] Carter, C. E., *J. Amer. Chem. Soc.*, **72**, 1466 (1950).
[6] Cohn, W. E., *J. Amer. Chem. Soc.*, **72**, 2811 (1950).
[7] Todd, A. R., and Brown, D. M., *J. Chem. Soc.* (in the press).
[8] Cohn, W. E., and Volkin, E., *Nature*, **167**, 484 (1951).
[9] Markham, R., and Smith, J. D., *Research*, **4**, 344 (1951b).
[10] Levene, P. A., and Simms, H. S., *J. Biol. Chem.*, **65**, 519 (1925).

OBITUARIES

Prof. A. J. Allmand, F.R.S.

Prof. A. J. Allmand, emeritus professor of chemistry in the University of London, died in hospital in London on August 11 after an operation.

He was the son of Frank Allmand and was born at Wrexham in 1885. He was educated at Alleyn's School, Dulwich, at Grove Park School, Wrexham, and at the University of Liverpool. He also studied at the technical high schools of Karlsruhe and Dresden. He took his D.Sc. in Liverpool in 1910 and then returned to study in Germany as a Science Research Scholar of the Exhibition of 1851. At Karlsruhe he worked under Prof. F. Haber on the measurement of radiation from flames, and at Dresden he worked under Prof. Luther on the primary products of photochemical change. He then took the post of assistant lecturer and demonstrator at Liverpool, where he was one of the group of chemists inspired by Donnan, whom he always regarded with gratitude and affection. At this period his work was naturally concerned with electrochemistry, and in 1912 he published his well-known text-book on the "Principles of Applied Electrochemistry", of which a revised edition was published in 1925.

During the First World War, Allmand was called upon to bring his knowledge and experience to bear upon the new problems of chemical warfare. He became chemical adviser to the Fourth, and later to the Second, Army H.Q., with the rank of major, and during this period he was awarded the Military Cross. His Army service left him with an enduring enthusiasm for military life and history which is somewhat unusual among men of science, and in his library the official history of the war jostled with the *Proceedings (A) of the Royal Society*, and was studied with equal diligence and zest.

In 1919 Allmand was appointed professor of chemistry at King's College, London, where he spent the remainder of his academic life until his retirement in 1950. While maintaining his interest in electrochemistry and developing the Drumm transport battery, he worked mainly in two other fields, namely, in the adsorption of gases and vapours by charcoal, and in photochemistry. In the latter field he was specially interested in photolysis and the photochemical reaction between hydrogen and chlorine. In both these fields he carried out a large amount of accurate experimental work which played an important part in future developments.

In 1938 he succeeded Prof. S. Smiles as Daniell professor and head of the Department of Chemistry at King's College. He was a member of the Senate of the University of London from 1929 until 1932, and he acted as assistant principal of King's College during 1937–43. He was elected a Fellow of the Royal Society in 1929 and made a Fellow of King's College in 1932.

During the Second World War, Allmand was again called to serve his country, this time as superintendent of the Explosives Research Department in the Ministry of Supply—an exacting task which he combined with almost nightly fire-watching duties at King's College. After the War his research interests returned again to electrochemistry, and his most recent publication dealt with the simultaneous electrodeposition of zinc and copper from solution. It was fitting that his last official position was that of president of the Faraday Society, a post which he held during 1947–48.

Although Allmand was a great teacher and a very distinguished physical chemist, it is more by his extraordinary personal influence that he will be remembered rather than by his purely scientific contributions. He was one of the most loved and revered members of the Common Room at King's College. His Department was singularly happy and harmonious. He was always greatly interested in the work and welfare of all his students, both while they were at College and afterwards when they occupied posts in universities or industry. They in turn regarded him with warm affection, and, at his farewell dinner, every year since his appointment was represented by a group of former students.

He was a man of complete moral integrity, whose whole life was inspired by spiritual purposes. His advice and judgment were always sound, selfless and rigidly based on principle. He was severe and ascetic with himself, although never censorious of others. On the rare occasions when he expressed disapproval, he was decisive and final; but he will be remembered more readily for the warm encouragement of his approval and the frequent generosity of his help. He was one of the most modest and self-effacing men in the College; but he has left a deep and enduring influence and a noble example.

He leaves a wife, a son and a daughter. His elder son, Michael, was wounded in the Burma campaign and was posthumously awarded the Victoria Cross for great gallantry in action. G. Temple

Prof. Hantaro Nagaoka

PROF. NAGAOKA was born on August 18, 1865, when Japan was in the midst of turmoil centring on the problem of the re-opening of trade and diplomatic relations with European countries and the United States after two hundred years of isolation from the rest of the world. He graduated from the College of Science of Tokyo Imperial University (now the University of Tokyo) in 1887, not long after it had been established by the new government. He obtained his doctorate in 1893 and, after having studied further in Germany for three years, he was appointed professor of physics at Tokyo Imperial University and held that position from 1896 until 1926. From 1926, he continued to carry out research at the Institute of Physical and Chemical Research (now Scientific Research Institute) in Tokyo until 1945. Even after he left the Institute, he was actively engaged in research work up to the very end of his life, which came on December 10, 1950, at the age of eighty-five.

Prof. Nagaoka published more than three hundred scientific papers covering a wide range of pure and applied physics, extending from hyperfine structure of atomic spectra to the theory of earthquakes. His earliest work on geophysics was followed by the investigation of magnetism, which was further extended by K. Honda. Then his interest turned to spectroscopy. In his latest years, he returned to various subjects on geophysics. Among numerous papers, however, he is best known by his pioneering work on the atom model, which appeared in the *Philosophical Magazine* in 1904. His Saturn model of the atom could be regarded, in a sense, as the forerunner of the Rutherford–Bohr theory. It is also worth while mentioning that he predicted the existence of the ionosphere quite independently of Kennelly and Heaviside.

Prof. Nagaoka was elected a member of the Imperial Academy of Japan (now the Japan Academy) in 1905 and was president of the Academy during 1939–48. He was the first president of Osaka (Imperial) University, which was established in 1931. He was elected an honorary member of the Physical Society of Japan in 1950 and was among the first who received in 1937 the Order of Cultural Merit, a medal of high distinction. Honours came also from abroad. He was elected an honorary fellow of the Physical Society of London in 1912, and received in 1925 the honorary degree of doctor of philosophy from the University of Cambridge.

His influence, both direct and indirect, was great on a large number of younger Japanese, who looked up to him as an outstanding native scientist, as they were eager to catch up with Western science and technology. He was a born scientist with a genuine love of Nature. His tireless endeavour for nearly sixty years in search of truth justly earned his reputation.

HIDEKI YUKAWA

Dr. C. D. Perrine

WE record with regret the death, which occurred on June 21, 1951, at the age of eighty-three years, of Dr. Charles D. Perrine, former director of the Cordoba Observatory, Argentine. Dr. Perrine began his astronomical career at the Lick Observatory in 1893. He made many observations of comets, and was active in discovering them, his discoveries including comets 1895 IV, 1896 I, 1896 VII (periodic), 1897 I, 1897 III, 1898 I, 1898 VI, 1898 IX, 1902 III. He was also the first to observe the periodic comets, D'Arrest at its return in 1897, Pons-Winnecke at its return in 1898, and Temple (2) at its return in 1899. In 1904 he discovered, on photographs with the Crossley reflector, the sixth satellite of Jupiter, and the following year the fainter seventh satellite; these two satellites form a pair with nearly the same mean distances (about seven times greater than that of the most distant of the previously known satellites) and have interlocking orbits. Their motions are subject to large perturbations. From observations with the Crossley reflector of Nova Persei 1901, Perrine discovered the expanding nebulosity around the nova, caused by the light from the outburst as it travelled outwards, illuminating the interstellar cloud in which the nova happened to be. From his observations of faint spiral nebulæ he was able to conclude that the number of such systems discoverable with this telescope was about half a million, providing the first evidence of the vast number of these objects, which has been fully confirmed by later observations. In 1903 he succeeded in obtaining the spectrum of Nova Aurigæ (1891) which was then of the 14th magnitude, and showed that it consisted of bright lines superposed on a continuous spectrum.

In 1909 Perrine left the Lick Observatory to take up the appointment of director of the Cordoba Observatory, a position which he held until his retirement in 1936. A fine series of photographs of Halley's Comet at its return in 1910, together with measurements of position and of brightness, were obtained, which formed the basis of a large volume, published in 1934, which contained excellent reproductions of many of the photographs, together with the observations and their discussion. Sixteen volumes of the "Resultados del Observatorio Nacional Argentino" were published under his direction. By his energy and enterprise, Perrine was responsible for the creation of the Astrophysical Station at Bosque Alegre, with its 60-in. reflector.

Perrine was interested in eclipse observations. He led the Lick expedition to Sumatra in 1901 to observe the total eclipse of May 18 that year, which secured successful observations. In 1914 he joined with Dr. W. W. Campbell, director of the Lick Observatory, in an expedition to the Crimea to observe the eclipse of August 21. Observations were hindered by clouds and the return journey was complicated by the outbreak of the First World War.

Perrine was awarded the Lalande prize of the Paris Academy of Sciences in 1897. In 1902 he was president of the Astronomical Society of the Pacific. He was elected an Associate of the Royal Astronomical Society in 1904, and at the time of his death was the senior, by nine years, of the Associates of the Society.

H. SPENCER JONES

WE regret to announce the following deaths:

Prof. Gilbert Cook, F.R.S., emeritus professor of civil engineering and mechanics in the University of Glasgow, on August 28.

Prof. T. H. Johnston, professor of zoology in the University of Adelaide, known for his work on the control of prickly pear in Australia, on August 30, aged sixty-nine.

Prof. G. Steindorf, formerly professor of Egyptology in the University of Leipzig, on August 28, aged eighty-nine.

NEWS and VIEWS

Sir Arthur Schuster (1851–1934)

Sir Arthur Schuster, who was born in Frankfurt-on-Main a century ago, on September 12, entered his father's business at Manchester in 1870. After studying physics and mathematics at Owens College, he took up spectrum analysis and went to work with Kirchhoff at Heidelberg, where he obtained his Ph.D. degree in 1873. Further study at Göttingen and Berlin was followed by his leadership, when only twenty-four, of the Royal Society's solar eclipse expedition to Siam. Subsequent expeditions took him to Colorado, Egypt and the West Indies. He became a naturalized British subject in 1875. After five years under Clerk Maxwell and Lord Rayleigh at the Cavendish Laboratory, Cambridge, he was appointed professor of applied mathematics at Owens College in 1881, succeeding his former teacher, Balfour Stewart, as Langworthy professor of physics in 1888. He was elected a Fellow of the Royal Society at the age of twenty-eight. He was secretary of the Royal Society during 1912–19, foreign secretary during 1920–24, and vice-president 1919–24; he received a Royal and the Rumford and Copley Medals. Schuster carried out important work on the discharge of electricity through gases, in meteorology, in terrestrial magnetism, and on the mathematical theory of periodicity; he was the first to photograph the spectrum of the solar corona. His classic "An Introduction to the Theory of Optics" was published in 1904. He was president of the British Association for the Manchester meeting in 1915, and was knighted in 1920. After his retirement from the chair at Manchester, he took an active part in fostering international collaboration in science, and was the first secretary of the International Research Council, which in 1931 became the International Council of Scientific Unions. Reserved and difficult to know, Schuster was always the friend of his students. He died on October 14, 1934.

National Physical Laboratory: Fifty Years of Progress

On January 1, 1900, Sir (then Mr.) Richard Glazebrook was appointed the first director of the National Physical Laboratory at Teddington, and although Bushy House, once a Royal residence, was not formally opened as the Laboratory proper until March 19, 1902, the Laboratory can be said to date from Glazebrook's appointment. Thus to celebrate the jubilee, an exhibition of the work of the Laboratory was held in the Royal Society's rooms on January 30, 1950 (see *Nature*, **165**, 257; 1950), and during May 23–29 this year the 'open days' of the Laboratory were intended partly as a jubilee celebration (see *Nature*, June 23, p. 1006). Bushy House with its gardens is still part, but now only a corner, of the fifty-acre estate on which sixteen major and minor buildings have been constructed to house the ever-growing needs of the Laboratory. The history of the growth and development of the Laboratory and the story of its many activities is of interest, not only to men of science all over the world, but also makes fascinating reading for the less technically minded public. The publication, therefore, of the Jubilee Book of the National Physical Laboratory (pp. 104+32 plates; London: H.M. Stationery Office, 1951; 4*s*. net) in time for the many visitors both from home and overseas in London for the Festival was greatly to be welcomed. Written by John Langdon-Davies and profusely and beautifully illustrated, it gives an accurate, interesting and easily read description of the way in which, in spite of difficulties and the increasing number of new branches of applied science, the Laboratory still gives pride of place to the science and art of measurement. The book consists of seven chapters, beginning with a discussion of the importance of accuracy in all the work at Teddington. Chapter 2 describes the origin of the Laboratory and chapter 3 its organization and relation to other bodies. The two succeeding chapters outline the maintenance of standards and the type of research that is undertaken, and the final two discuss some recent investigations and special types of research. There can be no doubt that the Laboratory will continue, as in the past, to be the champion of accuracy in measurement; an invaluable storehouse of equipment, techniques and personnel which could not be spared without serious loss to the nation's scientific capital; and an effective instrument for making existing scientific knowledge known as rapidly as possible to industry and others who are in a position to use it.

Research Council of Alberta

The thirty-first annual report of the Research Council of Alberta covering the year 1950, like earlier reports, stresses the importance of the investigations of the Athabasca bituminous sands, both as road material and as a source of liquid fuel. Co-operative experiments in the National Research Laboratories have demonstrated the feasibility of combining the hot-water separation process with the fluidized-bed cracking and distillation process, using the wet crude oil from the former as feed stock for the latter process; and by use of this combination the economic development of the bituminous sand is reported as immediately practicable. Besides further work on the cleaning, briquetting and balling of coal, studies on the constitution of coal have been made, including an investigation of the oxidation of low-rank Alberta coals. A preliminary survey was made of the Pleistocene deposits of the Edmonton area and a survey of automobile lubricating oils for sale within the Province was continued, as well as various other investigations of petroleum and associated products, including a study of anti-freeze solutions. Work continued on compaction studies on new road construction, and as a result of preliminary investigations on the causes of cracks in asphalt paving that do not appear to be associated with overloading of the road structure, consisting of pavement-supporting base and sub-soil, a detailed programme has been planned for the winter period. Two locations of unstable hillsides have been studied in detail to assess the soil conditions accompanying such instability.

The natural gas research programme comprises three current projects: the catalytic pyrolysis of natural gas in a fluidized bed; the kinetics and yields of the partial oxidation of butane in the gas phase; and an evaluation on the pilot plant of the National Research Council's process for carbon black from natural gas. An irrigation survey of the Bow River was completed as well as one of the Carmangay, and a preliminary survey of the William Pearce project for diverting some of the water of the Red Deer River. Some 400,000 acres were mapped in the Brazeau–Rocky Mountains House area, and about 1,750,000 acres in the McLennan and High Prairie area. Exploratory surveys were made of an area

north and west of Blueberry Mountain and of an area north of Hotchkiss. Accumulation of records of ultra-violet solar radiation with the thorium photocell continued, and a study is being made of the relative response at different wave-lengths of the three photo-cells used in the investigation. Problems of biological cycles, particularly the alternate prevalence and scarcity of forms of wild life, are being examined, including both the rabbit cycle and the collection of grouse material. A list of publications of the Research Council is appended.

National Foundation for Scientific Research, Brussels: Annual Report for 1949–50

THE twenty-third annual report of the National Foundation for Scientific Research, Brussels (pp. 196; 1950), covers the year 1949–50, and, besides lists of publications and of members of the scientific commissions, includes notes on the work in progress at Brussels, Ghent, Liège, Louvain, Mons and the Royal Military School. This has included studies on the following topics: the separation of isotopes by thermodiffusion in the liquid phase, the properties of uranium salts, the metallurgy of nuclear pure uranium, the preparation of pure graphite, heavy water, geological applications of radioactivity, neutrons, thick photographic emulsions, the preparation of uranium fluoride and hexafluoride, the variation of intensity of a pencil of neutrons with distance in terms of the medium interposed, the absorption of neutrons and the technique of the photographic plate. In addition, there have been some biochemical investigations, and studies in mass spectrography, the separation of isotopes, slow neutrons and nuclear isomerism, and the construction of a high-tension cathodic oscillograph and a linear accelerator of protons. In the financial statement, besides research grants totalling 3,125,000 francs for the year, the National Foundation has approved a supplementary grant of 2,000,000 francs for a Franco-Belgian expedition for submarine exploration, and 'extraordinary grants' of 212,971 francs to the University of Liège for the acquisition of a camera for cinematographic registration of rapid physical phenomena. Other grants are: 250,000 francs for the construction of an apparatus for X-ray emission and absorption spectra; 100,000 francs to the University of Liège for transporting and installing at the scientific station of the Jungfraujoch the cœlostat and large infra-red spectrometer from Cointe Observatory; 175,000 francs for sociographical research at the University of Brussels; 250,000 francs to the University of Louvain for a campaign of excavation at Alba Fucens; and 250,000 francs for equipping the four universities for biological research with radioisotopes. Besides a full list of publications by recipients of grants during the year 1949–50, there is appended a list of recipients of grants for 1950–51 and of their research objectives.

American Institute of Physics: Twentieth Anniversary

THE twentieth anniversary of the American Institute of Physics will be celebrated in Chicago during October 23–27 by a joint meeting of the founding societies of the Institute. Member societies which will hold their regular autumn technical meetings during the five-day anniversary celebration are the American Physical Society (October 25–27), Optical Society of America (October 23–25), Acoustical Society of America (October 23–25), Society of Rheology (October 24–26), and the American Association of Physics Teachers (October 25–27). The American Crystallographic Association, an affiliated society of the American Institute of Physics, will also participate in the anniversary meeting. An all-day symposium on October 25, on the theme "Physics To-day", will include papers by Dr. Enrico Fermi, University of Chicago; Dr. E. U. Condon, retiring director of the Bureau of Standards; Prof. J. C. Slater, Massachusetts Institute of Technology; Dr. Harvey Fletcher, Columbia University; and Dr. Edwin H. Land, president and director of research of the Polaroid Corporation. The symposium will be concluded with a more general talk entitled "Physics as Science and as Art" by Dr. K. K. Darrow, of the Bell Telephone Laboratories. Senator Brien McMahon, chairman of the Joint Congressional Committee on Atomic Energy, and Dr. K. T. Compton, chairman of the Corporation of the Massachusetts Institute of Technology, will be guest speakers at a joint banquet on October 25. Included in the programme will be an industrial exhibit of scientific instruments and apparatus arranged by the leading manufacturers of scientific equipment in the United States. Further information can be obtained from the Secretary, American Institute of Physics, 57 East 55th Street, New York City.

New Indian Institute of Technology

A NEW Institute of Technology, the first of four such institutes which it is hoped to build in India, is in the course of being constructed at Kharagpur, seventy-two miles from Calcutta, and already more than two hundred students are attending courses in buildings already in existence on the site. It is expected that the Institute will be finally completed and equipped in about four years time, and then it will be able to take about two thousand students. Mr. Jerzy Malanowski, a mechanical engineer, has recently gone to the Institute as the first member of a team from the United Nations Educational, Scientific and Cultural Organization under the United Nations Technical Assistance plan. Mr. Malanowski's work, besides organizing the four-year course in mechanical engineering and lecturing to students, will be to help plan and construct laboratories and workshops and their equipment for the Institute. Courses will be run on similar lines to those at the Massachusetts Institute of Technology. Departments of civil and sanitary engineering, electrical engineering, mechanical engineering, building construction and architecture, metallurgy, naval architecture and marine engineering, and geology and geophysics are being set up, and students will follow a four-year course leading to the degree of B.Sc. Eventually postgraduate courses, lasting a year, will be organized.

Measurement of Low Temperatures

SINCE the end of the Second World War interest in the field of low-temperature physics has expanded considerably, and there are now many more physical laboratories either engaged on, or about to embark on, low-temperature research work. Though the methods of measurement of temperatures below 90° K. are well established and are fully described in the literature, it would be difficult to find, if such exists, a comprehensive statement of them in any one book or periodical. The handy reference monograph on "The Measurement of Low Temperatures" (Research Report R–94433–2–A; Physics Department, Westinghouse Research Laboratories, East Pittsburgh, Penn.;

free) which C. T. Linder has compiled is therefore timely and should prove most useful. The contents of the monograph consist of details of the different methods of temperature determination, together with tables and graphs of data useful in the practical application of those methods. First, the low-temperature scale is briefly outlined, and then in more detail the gas and vapour thermometers, the thermocouple and the resistance thermometer are discussed. Finally, the measurement of temperatures below 1° K. is briefly considered, and the suggestion of Lawson and Long to use the Brownian motion, though not yet experimentally verified, is mentioned. The tables and graphs constitute nearly two-thirds of the monograph, and although the complete monograph is a photographic reproduction of typescript, the tables and graphs are exceptionally clear and easy to read. Every effort has been taken to make the material presented as up-to-date as possible. Table 2, consisting of seven pages, deals with the variation with temperature of the vapour pressure of helium and has been copied directly from material, dated June 1949, made available by the Royal Society Mond Laboratory, Cambridge.

Astronomical Photographs from the Yerkes Observatory

Since 1903 the Yerkes Observatory of the University of Chicago has been reproducing, in lantern slides, transparencies and prints, the original astronomical photographs made at Williams Bay. Within recent years, copies of photographs made at other observatories have been added to the collection, and these reproductions are sold by the University of Chicago Press. In "Astronomical Photographs", an illustrated catalogue edited by Thornton Page (pp. 36; Williams Bay, Wis.: Yerkes Observatory, 1951), the reproductions are listed and can be ordered by catalogue number from the Photographic Service Department, Yerkes Observatory, Williams Bay, Wisconsin. One hundred $3\frac{1}{4}$ in. × 4 in. slides for the use of teachers and lecturers are available, and at greatly reduced cost sixty selected slides are now offered in the 2 in. × 2 in. size, and on 35 mm. film strip, the former at 25 dollars for the sixty and the latter at 10 cents each. In addition to the set of selected slides for general use, the catalogue lists and describes slides and photographs illustrating specific research problems of modern astronomy and astrophysics—problems of the solar chromosphere and corona, of planetary atmospheres, of the origin of the solar system, of the aurora borealis, of lunar craters, of meteor and comet spectra, of interstellar clouds, of novæ and supernovæ, of the spectra of all types of nebulæ, and of galactic structure. The list finishes off with maps of neon and iron spectra, views of modern and historical instruments, and portraits of ninety famous astronomers.

Petroleum Consumption and Production in Great Britain

The Petroleum Information Bureau has recently issued a pamphlet (pp. 8; London: 29 New Bond Street, W.1; 1951), at the behest of the U.K. Petroleum Industry Advisory Committee, setting forth statistics on consumption of petroleum products; deliveries of motor spirit to dealers and commercial consumers; analysis of deliveries into consumption of gas, diesel and fuel oils; production of petroleum products from imported and indigenous crude and process oils; and indigenous materials made available for distribution by the petroleum industry. From the statistics given it appears that, during 1950, 5,195,173 tons of motor spirit, including motor benzole, were consumed in Great Britain. Considering that petrol rationing was not lifted until May 1950, this is a high figure, one, however, certain to be greatly exceeded for the current year. Total deliveries of gas, diesel and fuel oils for burning and power in the same year amounted to 5,337,791 tons. During the year Great Britain produced 949 tons of indigenous petrol by low-temperature carbonization, 130,177 tons of petrol and aviation spirit by hydrogenation and 188,842 tons of refined benzole—not an unworthy record.

Cambial Injuries in a Pruned Stand of Norway Spruce

A Forestry Commission publication, Forest Record No. 4 (pp. 12; London: H.M. Stationery Office, 1950; 9*d*. net), by W. R. Day, is devoted to "Cambial Injuries in a Pruned Stand of Norway Spruce" and is based on an experiment made of pruning the side branches of Norway spruce with the object of raising the quality of timber and so the economic value of the crop. One of the pruning experiments was carried out in Drummond Hill Forest on Loch Tay-side, Perthshire, at four different times of the year—May, July, October and January. Unpruned control plots were maintained, and all the plots had been brashed up to a height of about 6 ft. The trees in the forest were planted in 1912 and were thirty-five years old when examined in 1947. In a summary of the research work undertaken, the author says that a severe case of bark necrosis occurred, owing to frost damage, usually after the pruning had taken place and either at the beginning or end of the growing season. The damage to the unpruned trees was much less severe. The wood made by the spruce is abnormal in that its cell walls are of a weak structure and tend to be insufficiently lignified, especially the late wood. A typical feature of these trees is that the annual ring ends abnormally, indicating that their growing season is unduly long considering the type of climate in which they grow. The experimental demonstration of the diagnosis put forward in this paper is under consideration. The technical difficulties are involved, and research will be required into the relationship between provenance of spruce seed, that is, of the variability of a species and the relative usefulness of its variations in any particular region. Research is also required in the type of wood developed in Great Britain and susceptibility to the type of injury here described—a matter of some importance, for the results might seriously affect the productive efficiency of future plantations.

Chestnut Blight

The symptoms of chestnut blight, caused by the fungus *Endothia parasitica*, are described and illustrated in colour in Booklet No. 3 of the Forestry Commission (pp. 4+4 pl.; London: H.M. Stationery Office; 1950; 2*s*. 6*d*. net). This is a disease of the sweet chestnut, *Castanea sativa*, which has not yet been found in Great Britain; it has, however, caused very serious damage in the United States and is established in Italy and Spain. There is sufficient sweet chestnut in France to form a potential infection-bridge to the fairly extensive coppices of this tree in the south of England, and it is therefore highly desirable to recognize any possible occurrence in

Britain and to limit its spread, if discovered. The fungus attacks the bark, girdles the tree with a typical canker and kills the part beyond the canker. Orange-yellow spore tendrils are produced in moist weather, and the fungus also produces mycelial fans under the bark. Chestnut blight can be distinguished from ink disease of the same tree in that the latter kills the tree completely, whereas the former often allows normal growth in the part below the canker. The Forestry Commission invites reports of suspected cases of the disease to its Research Station, Alice Holt Lodge, Farnham, Surrey. It is pointed out that material should be packed in a tin to avoid spreading fungus spores during transit.

Animals of Scotland

To accompany a new section devoted to animals of Scotland in the "Habitat Court" of the Glasgow Art Gallery and Museum, a suitable booklet has been prepared by the curator of the natural history department. This describes the appearance and habits of the twenty-eight mammals and birds included in the exhibit as well as their general taxonomic characters. Other exhibits are concerned with the animals of Africa, India and Australia, and the number of visitors they are attracting indicate their popularity. A fifth exhibit, featuring animals of arctic and antarctic regions, is under construction.

Fear and Social Structure

According to Dr. Grantly Dick Read, the influence of fear on social structure is not well understood or appreciated (*South Afr. J. Sci.*, **47**, No. 8; March 1951). Practically the whole basis of human communal existence to-day, he suggests, is influenced by fear; man's mental and physical health vary as to his ability to remain balanced in face of fear. Dr. Dick Read also suggests that children are not only emotionally influenced from the moment of their birth but even from the moment of conception. At fifteen weeks the reflexes of the fœtus indicate individuality of behaviour. From birth the child is regularly subjected to stimuli which induce fear and lead to insecurity. According to its nature the child risks rebellion in violence or excessively anti-social behaviour, or resolves into that submissive state when even attempted activity of any sort, or any expression of its individuality, is paralysed by the deeply implanted fear of consequences. Dr. Dick Read believes that much of this unnecessary fear with its harmful effects on the individual and society would be eliminated if the fear of child-birth in women were eliminated.

Montefiore Prizes for Electrical Development

Montefiore Prizes, awarded by the George Montefiore Foundation of Liège, have been awarded to Dr. U. Krabbe (Fruens-Bage, Denmark), for an essay on "The Transductor Amplifier"; Dr. M. Hoyaux (Charleroi), for an essay on "Théorie de la chute dans l'arc des redresseurs à vapeur de mercure"; E. H. Hubert (Liège), for an essay on "Contribution théorique et expérimentale aux possibilités d'application du réenclenchement automatique des disjoncteurs"; and R. Pellisier (Paris), for an essay on "La propagation des ondes transitoires et périodiques le long des lignes électriques". These Prizes are usually given every five years; but the present awards are for the period 1939–50. They were established by a bequest of M. Montefiore, who founded the Electro-Technical Institute of the University of Liège, and are given for original contributions of scientific or technical significance for electrical progress. The committee of award consists of five Belgian and five non-Belgian engineers. Seventeen essays were submitted on this occasion. Particulars relating to the awards can be obtained from the Fondation George Montefiore, Université, Liège; the next awards will be made in 1955.

Unification of the "Air Almanac" and the "American Air Almanac"

As from 1953, the "Air Almanac" and the "American Air Almanac" will become a single publication, under the title of the "Air Almanac". It will be produced jointly by H.M. Nautical Almanac Office of the Royal Greenwich Observatory, Herstmonceux, and the Nautical Almanac Office of the U.S. Naval Observatory in Washington, to meet the general requirements for air navigation in the United Kingdom, the United States and Canada. The "Air Almanac" will be printed and published separately in England and the United States, but will otherwise be identical. A number of changes have been necessary in both the former publications. None of these has any effect on the principles of tabulation or on the use of the "Almanac" in navigation.

British Institution of Radio Engineers: Premiums for 1950

The British Institution of Radio Engineers has awarded the following Premiums for 1950, the awards being based on papers (titles as indicated) published during the year in the *Journal* of the Institution: *Clerk Maxwell Premium* (for the most outstanding paper of the year), to D. W. Heightman, English Electric Co., Ltd. (propagation of metric waves beyond the optical range); *Heinrich Hertz Premium*, R. Kompfner, Clarendon Laboratory, Oxford (operation of the travelling-wave tube at low level); *Louis Sterling Premium*, J. E. B. Jacob, Cinema Television, Ltd. (high-performance television monitors); *Dr. Norman Partridge Memorial Award*, S. W. Punnett, University College, Southampton (audio frequency selective amplifiers).

Announcements

Prof. Emile Guyénot, *correspondant* for the Section of Anatomy and Zoology of the Paris Academy of Sciences and professor of zoology and comparative anatomy in the University of Geneva, has been elected a non-resident member of the Academy in succession to the late Prof. L. Cuénot, formerly professor of zoology in the University of Nancy.

Prof. G. L. Brown, Jodrell professor of physiology in the University of London, and Sir James Learmonth, regius professor of clinical surgery and professor of surgery in the University of Edinburgh and surgeon to H.M. The King, have been appointed members of the Medical Research Council as from October 1.

The annual 'open day' at the Chemical Research Laboratory (Department of Scientific and Industrial Research), Teddington, will be on September 19.

The Medical Research Council announces that travelling awards in ophthalmology and otology under the Alexander Pigott Wernher Memorial Trust, tenable during the academic year 1951–52, have been made to Dr. Patricia R. Davey (Sydney) and Dr. R. N. Misra (Medical College, Lucknow).

CHEMISTRY AND TECHNOLOGY OF METALS AND ALLOYS

THE joint meeting of the Sections B (Chemistry) and G (Engineering) of the British Association, held on August 14 at Edinburgh to discuss "Metals and Alloys", was noteworthy because it was the first time in the history of the Association that a meeting had been devoted exclusively to subjects of metallurgical interest. This was pointed out in his opening remarks by the chairman, Sir Andrew McCance, who went on to remind his listeners that announcements of historic metallurgical importance have nevertheless been made at earlier meetings; for example, at the Cheltenham meeting in 1856 Bessemer made the first public announcement of his revolutionary process for making steel from pig iron without fuel by blowing air through it. Sir Andrew aptly summed up the course of metallurgy during the past hundred years by saying that the latter half of the nineteenth century was devoted to developing the art of manufacture on an ever-increasing scale, whereas the first half of this century has been characterized by an equally intense endeavour to understand the scientific principles of the processes in use.

This was well illustrated by the paper on "Chemistry in Metal Extraction" given by Dr. F. D. Richardson. The study of the physical chemistry of metals and slags is a development of the past twenty-five years; and so far as the older metal industries are concerned, research has been aimed at establishing the physico-chemical background of existing processes, and no startling discoveries have been made. On the other hand, chemical research has been directly responsible for the methods of extracting such new and costly metals as titanium, zirconium and uranium. Concerning metal extraction at high temperatures, least is known about molten slags and mattes, and research is therefore required on the chemistry of molten silicates, oxides and sulphides and their mixtures. According to the picture so far developed, molten silicates consist of disordered three-dimensional networks of tetrahedral silicate groups (SiO_4). These groups share corners with one another via Si—O—Si 'bridges' which can be broken by the addition of metal oxides, with a corresponding decrease in viscosity. When all the bridges have been broken, addition of further metal oxide gives rise to oxygen and metal ions dispersed between silicate tetrahedra. Much confusion has arisen from theories of the formation of various kinds of molecular compounds in liquid slags; but Dr. Richardson stressed that the only entities that can be recognized as having a distinctive existence are the metal ions, the silicate tetrahedra (which carry a net negative charge and may be bridged together in varying degrees) and the excess oxygen ions.

The rates of reactions between slags and metals are not controlled by the chemistry of the processes which take place at the interface between them but by the diffusion of reactants and resultants to and from the interface, particularly in the slag, since diffusion in the slag is generally much slower than in the metal. The rates of refining processes with slags can also be increased by efficient mixing of the slag and metal. The partition of sulphur between slag and metal obtained in the blast furnace is much less favourable than can be obtained under equilibrium conditions in the laboratory, and Dr. Richardson suggested that pig iron of lower sulphur content might be made by mixing slag and metal in the ladle after tapping. This would be an additional operation; but the slag and metal would be readily available at the desired temperature. It might also be practicable to recover the sulphur from the enriched slag by blowing air or oxygen through it, and to use the sulphur dioxide evolved for manufacturing sulphuric acid. If so, the seven million tons of blast-furnace slag made annually in Britain would be a potential source of a hundred thousand tons of sulphur.

The second paper, by Prof. A. H. Cottrell, was concerned with "The Strength of Metals". The atoms in a slip plane cannot all slip simultaneously over their neighbours in the next plane; slip must begin at certain places and then spread. The term 'slip dislocation' is applied to the line boundary separating the region in which slip has occurred from the rest of the slip plane. Three important properties of a slip dislocation are: when a slip dislocation is moved in a slip plane the amount of plastic deformation in the crystal is altered; the stress needed to move a dislocation through a slip plane of an otherwise perfect crystal is smaller than the smallest observed yield-strength; and third, the stress needed to create a dislocation in a perfect lattice is larger than the highest observed strength. This last property implies that slip dislocations must be present in crystals before they are plastically deformed. Support for this idea has been provided by Frank's theory of crystal growth, according to which growth occurs by deposition along spiral terraces on crystal faces, the centre of each spiral being the point where a dislocation line emerges from the interior of the crystal. On this theory the imperfect crystals, that is, the ones containing dislocations, are those most likely to grow. Growth spirals have been observed on both inorganic and organic crystals.

Prof. Cottrell then showed how dislocation theory explains the effect on the yield-strength exerted by foreign atoms, precipitates, crystal boundaries and other irregularities which are obstacles to the propagation of dislocations. Strain-hardening—one of the first problems to be studied from the point of view of dislocations—is the outstanding unsolved problem facing the theory. According to recent work the initial dislocations tend to assemble in sheet-like arrays that are very stable and act as barriers to the propagation of later dislocations; these special arrays of dislocations appear to be the main cause of strain-hardening; but it is not yet known why they are formed in the first place and why they are so stable.

A survey of alloy development during the past ten years or so was given by Prof. A. G. Quarrell. To a large extent new alloys are developed to meet the needs of the engineer, and the gas turbine has provided an incentive for the development of alloys with improved high-temperature properties in much the same way that the needs of the aircraft industry led to the introduction of alloys of better strength-to-weight ratio. For the most part the improvement of alloys is still empirical, depending upon the 'metal sense' of the metallurgist, and most of the alloys now technically important are complex, containing from six to ten alloying elements. It is to be hoped that, as the theory of alloy formation becomes more com-

plete, it will be possible to design alloys on a more rational basis and possibly with greater economy of alloys.

After reviewing some of the characteristics of "Brittle Fracture in Mild Steel", which has become so important since the introduction of welding on a large scale into shipbuilding, Mr. T. S. Robertson went on to describe a new form of test for the assessment of brittleness. In this test a shock crack propagated at low temperature passes through material stressed to a value comparable with that carried by the structure in practice. A temperature gradient is maintained along the direction followed by the crack, and this enables the temperature at which the material arrests propagation of the crack to be determined. As the transverse stress is reduced there is a sudden drop in the temperature at which the propagating crack is arrested, and Mr. Robertson suggested that this stress could be regarded as a safe design stress below which there is no chance of brittle fracture at ordinary working temperatures. Mr. Robertson illustrated his remarks with an excellent colour film of a test in progress. This showed that the speed of crack propagation is such that for the usual travel of about six inches, photography at 4,000 frames per second is too slow to record it, since no film so far taken has shown the crack in process of development. The speed of propagation must therefore exceed 2,000 feet per second.

In discussion Prof. J. A. Pope reminded the meeting that engineers are specially interested in the dynamic properties of metals. Under fatigue conditions the nature of the surface is most important: for example, light alloys tested with the as-extruded surface show much poorer properties than when the surface is carefully polished. Again, engineers are interested in machinability. If easily machined alloys are used, it might be possible to use water-cooled gas-turbine blades and to maintain a lower metal temperature by taking advantage of the stationary 'air' layer adjacent to the blade surface.

GENETICS AND EMBRYOLOGY

A DISCUSSION on the relations between genetics and embryology was held by Section D (Zoology) of the British Association on August 9. In introducing the topic, Prof. C. H. Waddington pointed out that when Bateson invented the word 'genetics' he defined it as the science which dealt with the physiology of descent, a phrase which could be held also to cover the subject which is usually known as experimental embryology. In spite of this, these two branches of biology, both of which have grown extremely rapidly in the past few decades, have developed almost in isolation from one another. After the disproof of at least the simple forms of the theory that differentiation is due to differential nuclear divisions, the concepts commonly used in them gradually diverged. Genetics came to envisage development in terms of the control of single chemical substances or enzymes by nuclear genes; while experimental embryology operated with the notions of gradients, on one hand, and active substances or regions, such as specific plasms or organizers on the other, neither of these types of agent being essentially connected with the nuclei. In quite recent years, these two categories of thought have begun to come together again. Thus, experimental embryology has been driven to recognize the fundamental importance of developmental competence, and to realize that this property is controlled, at least in the main, by genetical factors; while genetics has discovered that the connexion between gene and final product is not simple, but involves a balance between interacting forces which issues in a condition similar to the competence postulated by the embryologists. It may be hoped therefore that the natural unity between genetics and embryology will come to full expression in the near future.

Dr. R. A. Beatty then discussed some aspects of the importance of chromosomes in development, particularly in mammals. He described the occurrence of polyploids in mice. Triploid embryos are found to occur naturally in certain strains, and both triploids and tetraploids can be induced by hot shocks applied to the early stages of the eggs in the Fallopian tubes. So far no polyploids have been observed after birth; but the embryos appear to develop normally to mid-term, and it is hoped that polyploid young will shortly be identified. Turning to a rather different subject, he pointed out that evidence has been gradually accumulating that the cells of differentiated mammalian tissues may contain very different numbers of chromosomes. It does not seem plausible to attribute this to the technical difficulties of counting the chromosomes. There is no evidence that the type of differentiation is correlated with chromosome number; it seems more probable that neighbouring cells can co-operate, so that the important matter is the chromosome balance in the whole tissue rather than in the individual cells composing it.

Dr. D. S. Falconer pointed out that one approach to developmental genetics is to regard a mutation as causing a 'natural experiment'. It may be possible to show that the mutant gene produces some rather simple effect early in development and to trace a whole series of later modifications back to this original cause. As an example of such an approach, he described the analysis of a recent mutation in the mouse known as 'Crinkled'. The main initial effect seems to be the prevention of the formation of hair follicles except during a short period just before birth. This has a direct effect on the coat as a whole, which lacks the long guard hairs, normally initiated at an early period, as well as the short 'zig-zags', which are normally initiated after birth. It also explains the existence of certain localized bald patches, the absence of certain vibrissæ, and, by its effect on the growth of the skin, the distortion of the vertebræ of the tail from which the gene gets its name, as well as a number of other minor effects.

After the discussion, a series of cinema films were shown, one of which demonstrated the technique used for inducing polyploidy in mouse eggs.

SHIPBUILDING

AN international conference of naval architects and marine engineers was held during June 25–30, with proceedings in London, Glasgow and Newcastle upon Tyne.

The first paper read in London, "Ships Structures—A Century of Progress", by Mr. R. B. Shepheard, of Lloyd's Register of Shipping, traced the development of ships' structures from the wooden ships in general use one hundred years ago, through the stages of iron and riveted mild steel to the modern

welded steel ship. With certain noteworthy exceptions, progress following the introduction of new methods of shipbuilding has been delayed by persistent attempts to reproduce the traditions of the earlier methods in the new material.

The application of scientific principles to the structural design of ships developed from the earlier work of Grantham and Fairbairn about ninety years ago, until some forty years later rational methods of obtaining the distribution of material in the section of a ship were developed, largely due to the work of Foster-King, Bruhn and Isherwood. Since that time, research on the behaviour of ships' structures and component structural members has continued in order that further economies might be effected in the light of increased knowledge. The recent introduction of welding on a large scale has presented the designer with many new problems.

Developments of shipbuilding during the Second World War, particularly in the United States, brought to light the importance of notch toughness in mild steel, several major failures occurring due to lack of this quality. This problem of notch toughness which, so far as it relates to ship structures, was isolated in Great Britain in the Engineering Laboratory, Cambridge, as long ago as 1944, is being attacked by metallurgists and engineers in many countries.

Changes in the design and arrangement of dry cargo ships over the past fifty years have tended to increase the bending moments for the loaded condition at sea. In the case of the larger tankers, where there is considerable flexibility of loading in the ballast condition, a stage has been reached where the design must be developed with defined limitations on service schemes of loading.

Another paper, "Proposed Design for a Combined Research, Training and Cargo Ship", by Prof. H. E. Jaeger and J. C. Arkenbout Schokker, must have been of particular interest to shipbuilders in Great Britain owing to the very extensive work in the same field which is being carried out for the Admiralty Ship Welding Committee. It developed the interesting idea of building a dry cargo ship of about 9,500 tons deadweight which would serve the triple purpose of: (*a*) a training ship for officers and engineers for the merchant marine; (*b*) a research ship in which problems on ships' structures and performance could be investigated; and (*c*) a cargo ship engaged in normal trade partly to give realistic conditions for both training and research and partly to offset the cost of the project. This use of the ship for trading purposes would be subordinated to the needs of training and research.

The authors suggested that the most suitable size for such a vessel would be about 472 ft. length (B.P.) and 68 ft. breadth. The displacement would be 15,000 tons and the desirable speed 17 knots, requiring engines of about 8,700 S.H.P. The initial installation should be a diesel electric set installed aft with provision for the substitution of a gas-turbine motor at a later date. Suitable accommodation is planned for the large number of officer cadets and research workers, in addition to the normal complement.

The structure of the ship would include examples of several different types of construction. For example, the fore part would be longitudinally framed, whereas the after part would be transversely framed. Several different types of bulkhead stiffening would be fitted, including some corrugated bulkheads. All bulkheads would be designed to allow the holds to be filled with water up to the level of the shelter deck. This would enable large bending moments and other actions to be applied to the ship during structural tests. Various types of roll-stabilizing equipment would be installed for testing the relative merits of different systems.

No details were given by the authors of the equipment for measuring and recording the forces acting on the ship at sea and the strains induced in the structure. There would, of course, be the great advantage over the recent British experiments on the S.S. *Ocean Vulcan* that the installation of instruments could be made while the ship was under construction.

More rational methods of designing ship structures can only be developed with confidence when more is known of the actual forces to which the structure is likely to be subjected, so that the authors' proposal that several research ships should be built and operated in all parts of the world is attractive. Unfortunately, such experiments are costly, not only in the initial outlay on the ships and in their running, but also in the reduction to useful form of the vast amount of records collected on each voyage.

The cost of such full-scale experiments compels naval architects, as it does engineers in so many fields, to attempt to collect information from model tests such as those described by J. C. Niedermair, of the Bureau of Ships, in his paper "Ship Motions". The paper describes a series of experiments on the behaviour of five ship models of widely differing forms under steady wave conditions. In most of the tests a constant propelling force was applied to each ship in turn, and the amplitudes and periods of the resulting motions were measured together with the mean speed of advance through the waves. In the testing tank used, it was only possible to propagate waves the direction of advance of which was parallel to the ship's course. The full-scale dimensions of the waves used ranged from 300 ft. to 900 ft., and the full-scale heights lay between 19 ft. and 33 ft., while the lengths of the ships were from 380 to 550 ft.

Remarkable changes in the mean speed of advance were shown with changes in wave-length. Despite a great difference in form of the ships, the five models showed like characteristics. Each model exhibited a minimum speed for constant propelling force when the wave-length was about equal to the ship's length.

Curves giving the pitch amplitude as a function of wave-length show that the ratio of maximum pitch to maximum wave slope continues to increase with increasing wave-length at least until the wave-length equals twice the length of the ship. It is significant that no irregularities occur in these curves around the value of wave-length which should theoretically cause resonant pitching. The experimental records have been related to the theoretical analysis recently published by Weinblum and St. Denis, and found to be in general agreement. The pitching periods during these tests were those of the period of encounter, although it is generally accepted that a ship in a seaway pitches usually to its own natural period. It appears that the severity of the forcing motion used has masked the natural oscillations of the ship.

Not unnaturally, the authors feel the need for the verification of the similarity of ship and model motions, and they point out that this would involve instrumenting a ship fully, both to record ship motions and to record simultaneously the surface of the sea. All ways, therefore, seem to point to the need for more research ships.

CANCER RESEARCH IN GREAT BRITAIN

TWO annual reports which have recently been published, those of the Imperial Cancer Research Fund* and of the British Empire Cancer Campaign†, record the slow but steady progress that has been made in cancer research during the past year. The report for 1948 of the Imperial Cancer Research Fund gave first place to an account of certain investigations which lent weighty support to the virus theory of cancer, in that it was thought that what had been done since the classical work of Peyton Rous in 1911 on the chicken tumour could be reproduced on a mammalian tumour. It had been shown in the Fund's laboratories that mouse tumours could be frozen and dried, yet could still be successfully transplanted into mice. Freeze-drying kills cells but not viruses, and so it is considered that mouse tumour is transmitted by a virus liberated from the killed tumour cells.

The assumption of this essential condition did not survive tests at some other centres of cancer research. It was soon shown that freeze-drying, if carried to a more-or-less advanced stage, still leaves some viable cells which can be demonstrated by their growth in tissue culture. The positive results on inoculation can therefore be explained without invoking a virus as the agent for transmitting the tumour.

In the present report, the director of the Fund, Dr. James Craigie, frankly states that the mammalian virus hypothesis of tumour transplantation can no longer be considered. He has found, however, that the cells of a mouse tumour contain, in addition to the usual neoplastic cells, another type of cell characterized by being highly resistant to freeze-drying and by its high refractility. It can only be recognized by phase-contrast microscopy. He suggests that the cells of some tumours can assume the refractile state and that these cells can also change back into "normal tumour cells". The analogy with spore formation of micro-organisms is obvious.

The refractile cells are very potent tumour-carriers; only seventy-five cells are required to produce a tumour on inoculation into mice. "It has been found possible to obtain them (refractile cells) in considerable quantity for study, either by fractionating suitable suspensions prepared from subcutaneous tumours or by collecting them from the fluid which accumulates when tumour growth is produced by intraperitoneal inoculation . . . it was found that the refractile bodies were not stable in vitro but might change into recognizable tumour cells. . . . The discovery that the cells of some tumours assume this resistant state raises a number of questions. . . .". Clearly, these observations are of great importance and their development should do much to stimulate the biology of cancer.

Other studies at the Fund's laboratories at Mill Hill include those of L. Foulds on the responsiveness of some mouse mammary tumours to the hormonal influences which operate during parturition and lactation. An attempt is being made by P. C. Williams to induce similar effects by supplying hormones artificially to female mice bearing this type of tumour.

H. G. Crabtree has as yet found no straightforward relationship between the liver cancer inducing potency and the chemical structure of a series of azo-carcinogens. Reduction fission of the azo-compound yields a diamine moiety which selectively inhibits enzymes the activity of which is dependent upon intact sulphydryl groups; however, the correlation between carcinogenicity and potential inhibition shows some discrepancies.

E. Vazquez-Lopez finds that administration of thiourea to virgin mice of cancer-liable strains causes a significant decrease in the incidence of mammary cancer. After treatment by thiourea the œstrogenic secretion is re-established and mammary tumours begin to appear. These experiments suggest that "oestrogens are active carcinogenic agents independently of their primary morphogenetic functions".

Of the scores of researches described in the report for 1950 of the British Empire Cancer Campaign, the most attractive is by Sir Ernest Kennaway. Sir Ernest, who has recently celebrated his seventieth birthday, is too well known for his achievements in cancer research to need reiteration; the enigma of neoplasia has been compared to an uncharted ocean, and on this basis he could be called its Columbus. One of the reasons for the extraordinary interest of his essay is that it does squarely face the problem of the cause of cancer.

Cancer of the lung has undergone an immense increase of incidence in recent years—four times as high in an interval of fifteen years. Is this multiplication due to an increase in the inhalation of carcinogens, benzpyrene in town smoke or of arsenic in tobacco smoke? The analysis of twenty-seven brands of cigarettes shows that British, Canadian, American and Norwegian cigarettes contain the largest amount of arsenic (24–106 μgm./gm.), and Bulgarian the least, 0–1·2; Turkish tobacco contains little arsenic, 0–4·3. Nevertheless, the incidence of lung cancer is very high in Istanbul, for in 1946–48 the percentage of cancer of lung was thirty per cent of all cancer autopsies in males. In autopsies at St. Bartholomew's Hospital, London, the comparable figure was 41·17 per cent. Although no simple relation can be thus shown between lung cancer and arsenic in tobacco, the possible synergistic effect of this carcinogen cannot be ignored; a smoker can volatilize half a milligram of arsenic a day. Certain occupations have a low lung-cancer incidence, namely, agriculture, coal mining and mule spinning. The workers in the two last-named cannot smoke for a third of the day, and, in the first, atmospheric benzpyrene from town smoke is at a minimum. The aeration and temperature of the glowing tip of a cigarette is such as to render the production of benzpyrene negligible. In town smoke this carcinogen is due to the agglomeration of active domestic chimneys, for it is not emitted by properly working industrial furnaces or generating stations. The part played by other associated factors has still to be investigated—for example, the size of the particles in smoke containing the benzpyrene and the chances of these being retained in the bronchi and lungs, and secondly, the carcinogenic effect, if any, of components in the exhaust gases of motor vehicles.

"The finely divided carbon (in human lungs) . . . represents the intake of a lifetime. . . . The carbon itself may be innocuous, but from the study of atmospheric pollution . . . one can form some idea of the amount of benzpyrene which would accompany

* Forty-Eighth Annual Report of the Imperial Cancer Research Fund, 1950–1951. (Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2.)

† British Empire Cancer Campaign. Report for 1950. Edited by Sir Heneage Ogilvie. (11 Grosvenor Crescent, London, S.W.1.)

it. The small amounts of radioactive material, and of arsenic, which have been found in the dust of towns incline one to attach more importance to benzpyrene in this respect, but one must remember that: (*a*) we have no data upon the minimum effective dose of any carcinogen in man; and (*b*) we do not know whether the effects of different carcinogens upon the same tissue can summate."

Cancer of the larynx has increased of late years but not so rapidly as lung cancer, and this disease also shows a sex difference. Sir Ernest, in explanation, advances the stimulating idea that: "The differences in the anatomical, social and geographical distribution of cancer of the larynx in men, and in women, show that these two must be regarded as, to a large extent, different diseases; any statistics in which they are pooled are of no value. The larynx is a secondary sexual organ, hence such differences are not surprising. The adoption of smoking by women, and the increased consumption of tobacco and especially of cigarettes, by both sexes, has not affected the absolute numbers of cancers of the larynx in recent years; there has been no uniform change in either sex since 1930. As recently as 1929 the numbers of cancers of the larynx, and of the lungs, in males was about equal . . . since then, the deaths attributed to the latter have increased enormously".

After these examples of scientific thought and language, the approach to the rest of the report requires some little mental readjustment; most of the material presented is very technical and will be of great interest, and of course is mainly intended, for research workers engaged on closely allied branches of work.

Specialization is inevitable; but it carries with it a danger for cancer research, for each step in development implies more refined technique and more recondite treatment, and consequently there sometimes arises a tendency to encourage the pursuit of the means rather than the end.

A long report from the Clinical Cancer Research Committee on cancer of the lip, mouth and tongue is concerned chiefly with the compilation of abundant data rather than the extraction of generalizations.

Apart from the investigations mentioned so far, the principal themes of research have been threefold: physics and radiology (developments in radio-therapy, and changes in tissue brought about by X-rays); 'model experiments', that is, the study of changes induced in genic material and structures; and carcinogens and carcinogenesis.

The attention devoted to chemotherapy is rather less than in previous years; much more emphasis is being laid on the lines of the 'model experiments'. The agents used for investigation have been radiations, mitotic poisons, nucleotoxins, carcinogens and mutagens; the test objects have been cells in tissue culture, chromosomes, genes and nucleoproteins. The precise relation of this voluminous work to cancer is perhaps not obvious to the uninitiated. It depends upon the thesis that cancer is an aberration of growth, development, repair and differentiation, that these four features of cells and tissues depend in turn on the nucleus of the cell, that the dynamics of the cell are an expression of the structure, metabolism and influence of the nucleoproteins, and, finally, that genes and viruses have largely the same type of chemical nature.

J. F. Danielli and collaborators have succeeded, using microdissection, in transplanting the nuclei of two amœbæ giving an *Amœba proteus* nucleus living in an *Amœba discoides* cytoplasm. The next step is plain: these investigators should now try to transplant the nucleus of a tumour cell into the enucleated cytoplasm of a normal cell.

The histological alterations in the epidermal tissue of the mouse after X-radiation has been examined by A. Glücksmann, who found that destruction of the epidermis, hair follicles and superficial parts of the derma is followed by regeneration, scarring, a breakdown of the scar tissue and a repetition of the whole process, without further radiation, which finally gives rise to squamous cell cancer.

J. W. Orr and co-workers have transplanted mouse skin, which had previously been painted with methylcholanthrene, on to some other part of the mouse; the striking fact has been revealed that the decisive pre-cancerous change has been effected in the subepithelial tissues although the methylcholanthrene-induced cancer arises in the epithelial cells: ". . . when the stroma has been adequately prepared by carcinogenic treatment it is not necessary that the epithelium growing on it should have been itself exposed to a carcinogen before carcinoma can occur. It also appears that carcinogen-treated epithelium may not become neoplastic when transferred to a healthy bed."

Two items dealing with cancer of the liver are also included: the report from the South African Cancer Association refers to the extreme susceptibility of the Bantu to liver cancer (forty times as high as in Europeans); C. Berman has now published his admirable studies in this field of cancer research in the form of a monograph, "Primary Carcinoma of the Liver" (H. K. Lewis, London).

ROYAL GREENWICH OBSERVATORY

ANNUAL REPORT

THE report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory*, presented at the annual visitation held on June 2, covers the period May 1, 1950–April 30, 1951, and exhibits the state of the Observatory on the last date. Only some of the more outstanding matters of general interest can be mentioned here.

Many will regret the fact that Flamsteed House, including the Octagon Room, is no longer under the jurisdiction of the Royal Observatory, as it has been converted into two flats for naval officers of the Royal Naval College. The Wren Building, taken over by the Ministry of Works, will be treated as an ancient monument, and repair work is now in progress. At Herstmonceux no work has yet started on the sites of either the meridian group or the equatorial groups, but the exact locations for the individual meridian instruments have been selected. Work has not proceeded as anticipated in the previous year's report, which stated that the building for the Cooke reversible transit circle was not expected to be completed before the spring of 1951; that the building for the photographic zenith tube was planned to be com-

* Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory read at the Annual Visitation of the Royal Observatory, 1951 June 2. Pp. ii+29. (Greenwich: Royal Observatory, 1951.)

pleted in the summer of 1951, and the pavilion for the Melbourne reversible transit circle by the middle of 1952. In addition, it was hoped that the buildings for the 26-in. and 28-in. refractors would be completed during 1952; but unfortunately no further building has been started, and it seems improbable that the target date of the end of 1953 for the completion of the removal of the Observatory to Herstmonceux will be attained.

The report follows the usual lines of those of previous years; but one matter is worth special attention as it contains great possibilities for the future. On the suggestion of Prof. R. O. Redman, long exposures were made on regions containing the most intense discrete sources of galactic radio noises, and it is intended to repeat the plates after a year to discover whether any very faint object shown has a large proper motion. Three first-epoch plates have already been secured in the direction of the source in Cassiopeia, three towards that in Coma Berenices, and one towards that in Cygnus. One second-epoch exposure on the Coma source has shown that the method used is unsuitable for the detection of a small displacement in one object among scores to be examined. A different procedure will be adopted in the future; second-epoch plates will be taken direct, and glass positives, prepared from the second-epoch plates or from the earlier plates, whichever happen to be the more exposed, will be used for detecting any proper motion that may be large enough to be seen.

As a result of the work on the solar eclipse of November 1, 1948, it seems possible that improvements could be made in the method by which the limb-contours were being reduced in Washington. The observers at Washington have sent an improved contour for librations corresponding approximately with the librations at the time of the eclipse, and plans have been developed for a more extensive application of the method at the total eclipse of February, 1952. It is proposed to make observations at two places near Khartoum which just lie outside the region of totality on both sides of the central line, and also at two places near Basra, similarly placed with respect to the central line. Long-focus cameras will be used at the Khartoum sites to photograph the eclipse with the object of obtaining the precise contour of the moon's limb during the eclipse.

About four pages are devoted to the work of the Nautical Almanac Office, and one rather disconcerting matter is mentioned at the beginning of this report. Although the junior staff has been up to its complement for the greater part of the year, it has not been possible to fill the vacant post of 'scientific officer', which has been unfilled since 1945. In the *Almanac* for 1952 three major changes which were announced in 1951 have been made; eighteen pages have been devoted to ephemerides of Ceres, Pallas, Juno and Vesta. The list of apparent places of stars has been replaced by an extended list of mean places of stars; elements of occultations have been omitted, but apparent places of occulted stars (pp. 321–329 in the *Almanac* for 1952) have been retained. The occultation machine, designed by Mr. J. D. McNeile and built by Mr. A. C. S. Westcott, has undergone a number of improvements, among which may be noticed that to the 'moon' system. The work was carried out at the National Physical Laboratory to a design by Dr. D. S. Perfect, to allow greater accuracy in setting the limb of the moon on a station and in other ways to provide more satisfactory results. Preliminary tests have shown a great improvement in accuracy; but at present it is impossible to say whether the times as determined by the machine will dispense with the necessity for prediction computations. The new form of *Abridged Nautical Almanac* for 1952, a preliminary notice of which has aroused considerable interest, was not published at the time of the compilation of the report, but has since appeared.

It is very satisfactory to know that so far the experience of observational conditions at Herstmonceux shows they are up to expectations. Over a period of nearly a year the amount of sunshine at Herstmonceux has been nearly fifty per cent higher than at Greenwich, the greatest excess of sunshine at Herstmonceux occurring in the afternoon; the greater amount of cumulus cloud at Greenwich is responsible for the difference. Although the night sky records at Herstmonceux show only a moderate excess of clear sky, the transparency there is much better than that at Greenwich, and the average definition is also superior. It is anticipated that the freedom from the glare of artificial lights at Herstmonceux will be of great benefit in all types of observations, and the staff is eagerly looking forward to the commencement of night observations free from the difficulties under which they were carried on at Greenwich for many years.

DEPARTMENT OF SCIENTIFIC RESEARCH, INDIA

THE report of the Department of Scientific Research, India, for 1950–51* states that investigations on atomic energy continued in research institutes and university laboratories all over India, and that important results have been obtained in the study of cosmic rays. A factory capable of processing annually 1,500 tons of monazite to give 207 tons of thorium nitrate, 1,500 tons of rare earth chlorides and 1,800 tons of trisodium phosphate will be completed during the present year. Valuable deposits of uranium and beryl have been discovered. An International Conference on Elementary Particles was organized at the Tata Institute of Fundamental Research, Bombay, during December 14–24, 1950. The Advisory Committee for Co-ordinating Scientific Work, presided over by the Prime Minister, reviewed the work and functions of the various departmental scientific committees and has established a scientific advisory committee to study and advise on methods of broadcasting, as well as a committee to consider the establishment of national parks and Nature reserves for the preservation of flora and fauna.

A directory of type cultures maintained at various places in India is being prepared, and attention has also been given to the improvement of the cultivation of pyrethrum plants and of the extraction, stabilization and formulation of pyrethrin. With assistance from the United Nations Educational, Scientific and Cultural Organization, an Indian National Bibliographical Centre is being established and this may also be developed into a national library. Sir C. V. Raman has continued his work on the diffusion of

* Report of the Department of Scientific Research for 1950–51. Pp. 22. (New Delhi: Department of Scientific Research, 1951.)

light in transparent media. Besides encouraging the study of geophysics in the universities, the Central Board of Geophysics is seeking to set up a central geophysical institute.

The Council of Scientific and Industrial Research records the opening during the period of seven national research laboratories: the National Chemical Laboratory, Poona, on January 3, 1950; the National Physical Laboratory, New Delhi, on January 21, 1950; the Fuel Research Institute, Dhanbad, on April 22; the Central Glass and Ceramic Research Institute, Jadavpur, on August 26; the Central Food Technological Research Institute, Mysore, on October 21, 1950; the National Metallurgical Laboratory, Jamshedpur, on November 26; and the Central Drug Research Institute, Lucknow, on February 17, 1951. The programme of work to be undertaken by these laboratories is indicated in the report. In addition, six regional coal survey stations are being set up to survey the coal resources of India.

The Central Road Research Institute, New Delhi, is studying the vitrification of bricks for road use, the improvement of bullock cart wheels and jointing compositions for aerodrome runways. The Central Building Research Institute, Roorkee, is investigating the use of indigenous building materials for houses, water-proofing agents to supplement the stabilizing action of lime sludge from sugar factories and problems in the manufacture of bricks. The use of myrobolan extract in the South India tannage and the manufacture of synthetic tannins from cashew shell and Bhilawan nuts are being examined at the Central Leather Research Institute, Madras.

Research schemes sanctioned by the Council during the year included the following topics: development of heavy-duty parts of internal combustion engines, hot-air engines and gas turbines and jet propulsion units; investigations of Indian medicinal plants, proteins from green leaves, gases in steel, and radio valves; and the manufacture of alcohol from bagasse and other agricultural wastes, of aluminium metal by electrolysis of anhydrous aluminium chloride and of synthetic sapphires.

A Board of Engineering Research, with five expert committees, has been established.

The report also outlines the broad policy to be followed by the national laboratories in giving technical assistance to industry.

SCIENTIFIC RESEARCH IN INDUSTRY IN BELGIUM

THE annual report, for 1950, of the Institute for the Encouragement of Scientific Research in Industry and Agriculture, Belgium*, records a distribution during the year of grants totalling 69,202,500 francs. Of this total, 16,715,000 francs went to the committee on mapping the soil and vegetation of Belgium for making a systematic survey of the pedological characteristics of Belgian soils and completing a pedological map of the kingdom, and 6,438,000 francs to the committee for the study of the diseases and nutrition of livestock, and particularly trichosomiasis and brucellosis. A subsidy of 5,607,000 francs was allotted for the construction of an electronic calculating machine, and one of 5,281,000 francs for investigations, during two years, on the improvement of the quality of milk and problems of interest to the butter and cheese industry. A grant of 5,120,000 francs was made for research on rational and intensive exploitation of grasslands in Belgium, and another of 4,300,000 francs for investigations for improving the development of orchards, including soil investigations, studies on fruit trees and their culture and the diseases of fruit and their prevention. The Institute granted 2,800,000 francs for the investigations on industrial and potable water and the treatment of effluents, and 1,950,000 francs for scientific and technical investigations on the culture of vegetables for preservation, the selection of varieties and on the biological, chemical and physical conditions for preservation.

Grants were also made of 1,492,000 francs for chemical and physico-chemical researches on high polymers, including the study of dielectric constants, and of thermodynamic properties, the fractionation of polymers and investigations on the co-polymerization of styrene with drying oils, the dissolution of acrylonitrile and the thermal stability of polyvinyl acetate; 1,230,000 francs for investigations on soilless culture directed to the determination of practical conditions and to the study of physiological aspects of mineral nutrition of general interest in agriculture; and 890,000 francs for investigations on the improvement of the cultivation, conservation and utilization of medicinal and aromatic plants. The Union for Electrical Development in Belgium received 850,000 francs for continuing its researches on furnace refractories. Grants totalling 820,000 francs were given for researches on medicinal plants collected during 1947–48 in the Belgian Congo, and 779,500 francs for genetic, entomological and technological investigations on both Belgian and Congo timber. The Belgian Institute for High Pressure received a further 771,000 francs for continuing its piezometric studies, its studies on manometric balances, and on the biological effects of high pressures, while 762,500 francs was given for research on the proteins of barley and malt, and 700,000 francs for the continuation of work on the effect of oxygen excess in the blast vent of the Thomas steel plant.

Smaller grants were made for the following purposes: road research (514,000 francs); mushroom cultivation (485,000 francs); improvement and cultivation of the strawberry plant (400,000 francs); manufacture of calcium cyanide (480,000 francs); behaviour of asphalt mastics (380,000 francs); plasticity of ceramic doughs (277,500 francs); organic matter in Belgian soils (228,000 francs); Belgian Institute of Welding for research on the use of ultrasonics for the auscultation of welds (227,500 francs); preliminary investigations on the utilization of metals (222,500 francs); use of explosives in mining demolition and in quarrying (168,500 francs); preservation of perishable produce by rapid freezing (121,000 francs); and for investigations on air liquefiers (85,000 francs).

A list of publications relating to researches subsidized between October 1, 1949, and December 31, 1950, is appended, and the Institute has also issued a pamphlet summarizing briefly its activities since it began to operate in 1945, showing the results achieved by the expenditure of some 240 million francs distributed over 173 subsidies.

* Institut pour l'Encouragement de la Recherche scientifique dans l'Industrie et l'Agriculture. Rapport Annuel 1950. Pp. 164. Cinq années d'activité: un Bilan, 1945–1950. Pp. 24. (Bruxelles, 1951.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Terminology for Use in Lactational Physiology

RECENT advances in the elucidation of the physiological mechanisms of lactation, particularly those mechanisms concerned in the transfer of milk from the mammary glands to the young, have revealed inadequacies and ambiguities in the terminology in common use in relation to lactational physiology. An example of such an ambiguity is the term 'to suckle', which is at present being used to denote the activity of the lactating mammal or the young or both. In 1947, one of us[1] proposed a scheme, now generally adopted, which classified and defined the major physiological components of the total phenomenon which is called 'lactation', and which has done much to clarify terminology in this field. We should now like to put forward additional terms which, if generally accepted, we believe will render the above-mentioned scheme more comprehensive and will largely resolve the ambiguities still in existence.

The terminology we propose is as follows:

Nursing. The behaviour of the lactating mammal in promoting access of the young to the nipples or teats.

Suckling (milking). The activity of the young (or operation of the milking device) with the aim of obtaining milk from the mammary glands.

Suckling (milking) stimulus. The sum of stimuli applied to the lactating mammal by suckling (or milking).

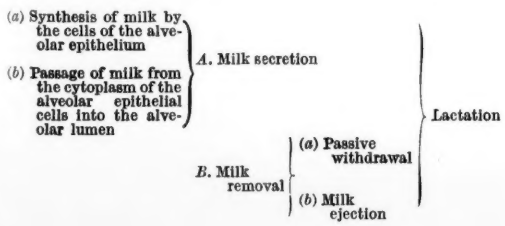
Alveolar milk. The milk stored in the lumina of the alveoli and ducts of fine calibre.

Sinus milk. The milk stored in the ducts of large calibre and lactiferous sinuses or cisterns.

Passive withdrawal. The removal of sinus (*or* cistern) milk which at low intramammary pressure can be brought about by the action of suckling or milking or by cannulation without the intervention of the special contractile tissue of the mammary glands.

Milk ejection. The effect of alveolar contraction elicited reflexly by the suckling or milking stimulus in mammary glands distended with secretion. It involves the movement of some alveolar secretion into the sinus or cistern (that is, alveolar discharge) thereby producing a rise in intramammary pressure (hitherto called 'let-down' or 'draught'). Milk ejection may or may not involve passage of milk to the exterior.

The scheme of Folley[1], illustrating the phases of lactation may thus be extended as follows:


(a) Synthesis of milk by the cells of the alveolar epithelium
(b) Passage of milk from the cytoplasm of the alveolar epithelial cells into the alveolar lumen
A. Milk secretion
B. Milk removal
(a) Passive withdrawal
(b) Milk ejection
Lactation

It is hoped that the terminology proposed will cover the phenomena formerly described by 'let-down', 'hold-up', and 'draught' in agricultural and medical circles, and that these latter terms will no longer be used, at least in scientific literature.

A. T. COWIE
S. J. FOLLEY

National Institute for Research in Dairying, University of Reading.

B. A. CROSS
G. W. HARRIS

Physiological Laboratory, University of Cambridge.

DORA JACOBSOHN

Department of Physiology, University of Lund.

K. C. RICHARDSON

Department of Anatomy, University College, London.

July 27.

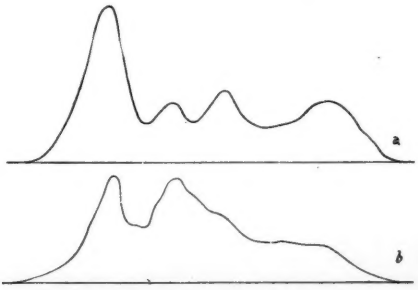
[1] Folley, S. J., *Brit. Med. Bull.*, **5**, 142 (1947).

Effect of Diseases on the Serum Albumin of Animals

IT has been shown by a number of workers that, in the case of man, one of the effects of disease is a lowering of the albumin concentration of the serum[1].

In our work on the electrophoretic composition of sera of sick animals, this finding has been confirmed. In all the conditions investigated—such as African horse sickness and equine trypanosomiasis; bluetongue and heartwater of sheep; lumpy skin disease and east coast fever of bovines; and biliary fever and rickettsiosis of the dog—a considerable drop in the albumin concentration occurred during the acute phase of the disease. It has been noticed, further, that the faster-migrating albumin component was reduced to a much greater degree than the slower-migrating component, thus producing asymmetrical albumin peaks in the electrophoresis diagram. The electrophoretic heterogeneity of human serum albumin was shown by Hoch and Morris[2]. In addition, the slower-migrating albumin component in the diagram becomes much sharper. This is further evidence of the preferential reduction of the faster-migrating albumin fraction.

The influence of disease on the serum albumin in the horse is illustrated here in the case of African



Electrophoresis diagrams of the serum of the susceptible horse (*a*) before inoculation with horse sickness; (*b*) at the peak of the reaction to African horse sickness

horse sickness. Fig. *a* shows the electrophoresis diagram of the serum of a susceptible horse; Fig. *b* is the diagram of the serum taken at the peak of the reaction to African horse sickness in the same horse after experimental infection. The dissimilarity between the two diagrams is obvious. In this communication attention will be paid only to the albumin component.

In the serum of the horse taken at the peak of the reaction the albumin component is reduced considerably and becomes quite sharp and asymmetrical. There is a distinct bulge on its side which indicates that the faster-moving albumin constituent is reduced in concentration. In normal serum at *p*H 8·6 at which these measurements were made, the two components migrate with velocities which differ only by a few per cent. It is only when the concentration of one component is reduced that the heterogeneous nature of the albumin is noticed.

So far as I am aware, the selective reduction of the albumin through the influence of a disease has not been reported by other workers in this field. This is due to the relative insensitivity of the usual optical methods employed in electrophoretic studies, as compared with the very sensitive Lamm scale method used in this work.

A. Polson

Section of Biophysics,
Onderstepoort.
April 2.

[1] Marrack, J. R., and Hoch, H., *J. Clin. Path.*, **2**, 161 (1949).
[2] Hoch, H., and Morris, C. J. O. R., *Nature*, **156**, 234 (1945).

Cocarboxylase in Experimental Diabetes

In previous experiments we have found that the injection of cocarboxylase causes, in the alloxan-diabetic rat, a diminution of the blood sugar and an increase of the respiratory quotient and of tissue glycogen. Thiamine produces similar effects; however, with severely affected animals it fails to act[1,2]. The hypothesis was then advanced that, in severe alloxan diabetes, thiamine does not produce any effect because its conversion to cocarboxylase is prevented. We have now obtained some evidence in support of this hypothesis.

According to Ochoa[3], the phosphorylation of thiamine occurs mainly in the liver; we have therefore estimated the cocarboxylase in this organ of the alloxan-diabetic rat after injection of thiamine.

Table 1. Stock rats of both sexes of 200 gm. approximately were used. Thiamine hydrochloride 20 mgm./kgm. body-weight by intramuscular injection; animals killed by decapitation 30 min. after the injection. Cocarboxylase was determined by the method of Ochoa and Peters (ref. 4) with minor adaptations (ref. 5)

Rats	No. of animals tested	Liver cocarboxylase (μgm./gm. wet tissue)	
		Range	Average
Normal	22	7·70–12·91	9·62 ± 0·28
Diabetic	25	3·24– 6·39	4·57 ± 0·16
Normal + thiamine	15	16·40–24·45	20·49 ± 0·67
Diabetic + thiamine	15	3·80–11·10	6·69 ± 0·61

It will be seen from Table 1 that in alloxan-diabetes a significant decrease of the cocarboxylase content of the liver occurs. This reduction was usually higher in those animals more severely affected. In the normal animals the injection of thiamine was followed by an increase of the liver cocarboxylase; this increase occurred in all the animals tested and exceeded 110 per cent.

In the diabetic rats the injection of thiamine was also followed by an increase of the liver cocarboxylase; however, this increase was much less than in the normal animals.

To see whether a relation existed between the respiratory quotient of the diabetic rat after injection of thiamine and the concentration of liver cocarboxylase, we have measured the respiratory quotient just before the injection of thiamine (20 mgm./kgm.) and glucose (5 gm./kgm.), and 60 min. later; after a few hours, another dose (20 mgm./kgm.) of thiamine was injected and the liver cocarboxylase determined.

The animals more severely affected by diabetes failed to show an appreciable increase of respiratory quotient; in these animals the cocarboxylase content of the liver remained very low, of the same order of that found in the untreated diabetic rats. On the other hand, in animals which showed an increase of the respiratory quotient after injection of thiamine, the liver cocarboxylase was considerably increased. Two typical results are given in Table 2.

Table 2. Respiratory quotient (R.Q.) measured by the method of Haldane–Margaria (ref. 6). Cocarboxylase determined a few hours after the R.Q. and 30 min. after an additional dose (20 mgm./kgm.) of thiamine

R.Q. of diabetic rats		Liver cocarboxylase (μgm./gm. wet tissue)
Before	60 min. after thiamine + glucose	
0·65	0·67	3·80
0·74	0·95	13·74

These results indicate that in alloxan-diabetes the phosphorylation of thiamine is partially or completely inhibited; by analogy, they could also offer an explanation for the high levels of blood keto-acids found in severe pancreatic diabetes.

We think that the lack of available insulin which characterizes the diabetic condition is the primary cause of the phenomena described.

A full report of this work will appear elsewhere.

D. Siliprandi
N. Siliprandi

Institute of Biological Chemistry,
University of Pavia. April 23.

[1] Siliprandi, N., *Acta Vitaminologica*, **4**, 259 (1950).
[2] Siliprandi, D., and Siliprandi, N., *Arch. Biol.* (in the press).
[3] Ochoa, S., in "The Biological Action of the Vitamins", by E. A. Evans, p. 17 (Univ. of Chicago Press, 1944).
[4] Ochoa, S., and Peters, R. A., *Biochem. J.*, **32**, 1501 (1938).
[5] Siliprandi, D., and Siliprandi, N., *Acta Vitaminologica*, **5**, 3 (1951).
[6] Margaria, R., *Biochem. Z.*, **270**, 444 (1934).

The Gelatinous Mass in Rabbit Semen

Rabbit semen consists of two main parts, gelatinous and fluid. After ejaculation, the gelatinous part fills the lumen of the vagina as a copulation plug (*bouchon vaginal*). The existence of a copulation plug, which prevents the semen running out of the vagina after ejaculation, has been observed[1] in a number of mammals besides rodents. Its importance in rats for fertile mating has been shown by Blandu[2]. That the production and maintenance of the gelatinous mass which mainly constitutes the copulation plug in the rabbit depends on testosterone has been shown by Parsons[3]. She found that castration in rabbits leads to complete absence of the gelatinous mass in ejaculates. When testosterone propionate was injected into such castrated rabbits, the gelatinous mass reappeared. She further found that implantation of stilbœstrol tablets into a buck

previously castrated and implanted with testosterone brought about an inhibition of sex drive as well as a sharp decrease in seminal fructose, but an increase in the gelatinous part. This increase in the gelatinous part, however, remained unexplained.

With the view of finding out the significance of the gelatinous mass in rabbit semen in normal mating, semen samples from six bucks were obtained in an artificial vagina. It has been found that the gelatinous mass per ejaculate varied from 0·34 to 4·19 gm., the average being 1·67 ± 0·36 gm. Fructose, the seminal nutrient for spermatozoa[4], is present in the fluid portion. The thoroughly washed gelatinous portion, when examined for fructose by the technique described by Mann[5], was found to have an almost negligible quantity. Incubation of semen samples with and without the gelatinous mass at the vaginal temperature of rabbit (namely, 40° C.) has shown that the rate of utilization of fructose in semen is positively correlated with sperm concentration of the sample. The rate, however, is uninfluenced by the presence or absence of the gelatinous mass.

Examination of the thoroughly washed gelatinous mass under the microscope revealed a large number of inactive spermatozoa encased in it. On incubating the mass at 37° C. in normal saline, it dissolved and the spermatozoa thus released were found to be highly active. The encasement of spermatozoa by the gelatinous mass is perhaps due to the fact that at the time of ejaculation both parts of the semen are in a fluid state. Subsequent gel formation of one part encases some of the seminal fluid containing spermatozoa in contact with it.

It has also been found that 800 mgm. of the gelatinous mass dissolved in 8 ml. of water at approximately 80° C., when injected subcutaneously after cooling in four equal doses with two injections a day at an interval of 8 hr. between the two injections into ovariectomized immature rats, produced keratinization of the vaginal cells after 96–120 hr. from the first injection. Similar results have been obtained by injecting 400 mgm. of the mass dissolved in 4 ml. of hot water into ovariectomized mice of approximately one month old. Subcutaneous injections were also given to eight adult male rats each of which received, in six equal doses with two injections a day, altogether 1·2 gm. of the mass in 12 ml. of water. The rats were killed on the ninth day from the first injection, and the histological examination of their testes revealed degeneration of the seminiferous tubules. There was also significant decrease in the weight of the seminal vesicles and a highly significant decrease in their fructose content compared with those of the control rats of the same age and body-weight. These findings, therefore, indicate that the gelatinous mass appears to contain œstrogenic substance in appreciable quantity.

We are indebted to Dr. S. N. Ray, of the Animal Nutrition Section of the Indian Veterinary Research Institute, for helpful suggestions.

D. P. Mukherjee
M. P. Johari
P. Bhattacharya

Animal Genetics Section,
Indian Veterinary Research Institute,
Izatnagar.
April 19.

[1] Engle, E. T., *J. Mammalogy*, **7**, 119 (1926).
[2] Blandu, R. J., *Anat. Rec.*, **91**, 266 (1945).
[3] Parsons, U., *J. Endocrinol.*, **6**, 412 (1950).
[4] Mann, T., *Nature*, **157**, 79 (1946).
[5] Mann, T., *J. Agric. Sci.*, **38**, 323 (1948).

Light-scattering Studies on Penicillin G Solutions

Literature concerning the physical-chemical state of aqueous systems of penicillin reveals a controversial issue. Claims that micelles, between 200 A. and 5000 A. in length, are formed above a critical concentration of 10,000 units/c.c. (0·6 per cent)[1–4] contrast with evidence which indicates that penicillins behave as simple electrolytes[5–9]. One paper[5] reports that colloidal electrolyte behaviour is not reached until 8·26 per cent, a concentration so high as to be of little biological importance.

In view of this controversy, a light-scattering technique, as used by Debye[10], which permits precise measurements of scattering over a wide angular range and which is admirably suited for studies of micelle systems, has been applied. From determinations of the dependence of turbidity and of the refractive index on concentration, molecular weights can be found by use of the well-known equation[11]:

$$\frac{1}{M} = \frac{32\pi^3}{3}\frac{{\mu_0}^2}{N\lambda^4}\left(\frac{\mu-\mu_0}{c}\right)^2 C/\tau$$

Furthermore, by analysis of the angular dependence of the scattered light, information about the size and shape of micelles is possible.

Studies have been made using Wyeth crystalline potassium penicillin *G* (Lot *EKD* 500804 containing 1,650 units/mgm.) in the concentration-range 3,000–30,000 units/c.c. A solution in water, at a concentration of 10,000 units/c.c., exhibits much less scattering than that of systems containing micelles as large as those previously reported for penicillin at that concentration[3]. For this reason, further studies have been made in solutions containing electrolytes, a condition which enhances micelle formation. Also, in the presence of electrolytes, aqueous solutions can be readily freed from dust particles by filtration through very fine sintered glass, and thus a danger which may lead to spurious observation of micelles is removed. In potassium bromide solutions of ionic strength 0·2 and 0·5 respectively, the angular scattering, about 90° over the whole concentration-range, exhibits perfect symmetry (Fig. 1).

Unless a scattering particle has some dimension greater than about one-tenth of the wave-length of the exciting radiation, no dissymmetry in the scattered light can be detected. In this case the symmetrical scattering reveals that, apart from the possible existence of a minute fraction of large particles, any particles present have a maximum dimension not greater than 300 A. For the same systems the value obtained by extrapolation of the linear graph of concentration divided by turbidity (C/τ in the equation) is 35 at zero concentration (Fig. 2). The refractive increment $(\mu - \mu_0)/c$ can be

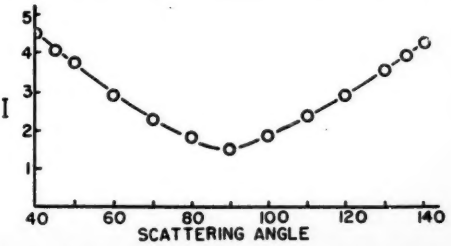


Fig. 1. Relative scattering intensity (I) of unpolarized light (λ = 4358 A.) by potassium penicillin *G* (13·9 mgm./c.c.) in 0·5 *M* potassium bromide

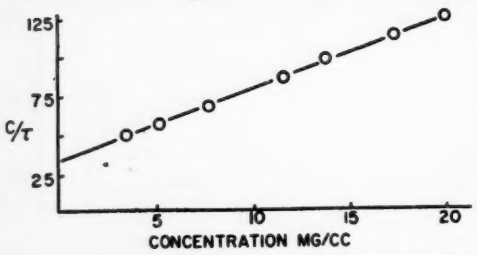


Fig. 2. Concentration-turbidity dependence for potassium penicillin *G* in 0·5 *M* potassium bromide

expediently determined with a differential refractometer and has a value of 0·185. Since these figures indicate a very low scattering system, in contrast to that expected from other work[3], we can ascribe a value of 3,000 as an upper limit to the molecular weight of any particles present.

The angular scattering data, Fig. 1, which indicate no dissymmetry, at once place an upper limit of 300 A. on any particles which may be present. In addition, the molecular weight maximum also dismisses the existence of large micelles of potassium penicillin *G* in the above concentration-range. Thus, although potassium penicillin *G* is slightly capillary-active, as evidenced by a small degree of frothing on shaking its solutions, the bulk phase contains associations of relatively few molecules even under conditions which enhance micelle formation and which also resemble more closely those encountered in biological systems.

I am indebted to Dr. F. Bueche for his interest and helpful discussions.

C. S. Hocking*

Baker Laboratory of Chemistry,
Cornell University,
Ithaca, New York.
March 15.

* Rotary Foundation Fellow, Adelaide, Australia.

[1] Hauser, E. A., *Kolloid Z.*, **111**, 103 (1948).
[2] Hauser, E. A., and Marlowe, G. J., *J. Phys. Coll. Chem.*, **54**, 1077 (1950).
[3] Hauser, E. A., Phillips, R. G., and Phillips, J. W., *Science*, **106**, 616 (1947).
[4] Hauser, E. A., Phillips, R. G., Phillips, J. W., and Vavruch, I., *J. Phys. Coll. Chem.*, **53**, 287 (1949).
[5] McBain, J. W., Huff, H., and Brady, A. P., *J. Amer. Chem. Soc.*, **71**, 373 (1949).
[6] Kumer, W. D., and Alpen, E. L., *Science*, **107**, 567 (1948).
[7] Lund, C. G., and Pedersen-Bjergaard, K., *Science*, **109**, 149 (1949).
[8] Klenow, H., *Acta Chem. Scandinavia*, **1**, 328 (1947).
[9] Woodbury, D. T., and Rosenblum, C., *J. Biol. Chem.*, **171**, 447 (1947).
[10] Debye, P., *J. Phys. Coll. Chem.*, **53**, 1 (1949).
[11] Oster, G., *Chem. Rev.*, **43**, 319 (1948).

So-called Non-adaptive or Neutral Characters in Evolution

The reaction that set in some thirty years ago against the facile assumption that all interspecific differences are adaptive was good but went too far. Several authors insisted that most specific and subspecific differences were non-adaptive. More recently, Mayr[1], while emphasizing the great importance of selection in speciation, considered that not all geographical variation is adaptive and, in particular, that most of the characters involved in polymorphism are completely neutral so far as survival value is concerned. Later[2], he reversed this judgment on polymorphism.

Carter[3] places considerable emphasis on neutral characters, quoting as evidence banding in the polymorphic snail *Cepæa nemoralis*, Mayr's demonstration of apparently irregular variation in populations of *Cacatua galerita triton* in New Guinea, and the distribution of certain third chromosome inversions in *Drosophila pseudo-obscura*. But Mayr himself points out (ref. 1, p. 89) that size variation in *Cacatua* is not random except perhaps for the population on Biak (and Mayr and de Schauensee[4] have shown that the birds of Biak, which may be in part a very old island, are often different from those of nearby territories). Dobzhansky and others[5] have shown that the inversions are definitely subject to selection; and Cain and Sheppard[6] have demonstrated that variation in *Cepæa*, so often quoted as random, is, in fact, selectively controlled. Other examples quoted by Carter show an apparent randomness of variation, and he considers that it is difficult to see how the characters concerned could have any concomitant effects which might themselves be subject to selection. This is the real basis for every postulate of random variation or (more recently) genetical drift. The investigator finds that he, personally, cannot see any correlations in a given example of variation, and concludes that, therefore, there is none.

In view of the complexity of living things and their environment, a more cautious approach should be used. So far, every supposed example of random variation that has been properly studied has been shown to be non-random. One must agree that some characters have no value in themselves. But when it is found that their variation is stably clinal or otherwise correlated with their environment and history, then selection acting on their concomitant effects must be admitted as the governing factor. Mayr[1] gives many examples. He contends that some clines are non-adaptive because apparently independent of environmental gradients. Here again we just do not know, and he admits that probably some selective factors are involved.

It seems only reasonable, therefore, to suggest that those characters or variation patterns that have been described as non-adaptive or random should properly be described as uninvestigated. One must not assume randomness (or selection) without proof.

A. J. Cain

Department of Zoology and
Comparative Anatomy,
University of Oxford.
April 9.

[1] Mayr, E., "Systematics and the Origin of Species" (Columbia, 1942).
[2] Mayr, E., and Stresemann, E., *Evolution*, **4**, 291 (1950).
[3] Carter, G. S., "Animal Evolution" (London, 1951).
[4] Mayr, E., and de Schauensee, R. M., *Proc. Acad. Nat. Sci. Philadelphia*, **91**, 1 (1939).
[5] Dobzhansky, T., *Genetics*, **28**, 162 (1943). Wright, S., and Dobzhansky, T., *Genetics*, **31**, 125 (1946). Dobzhansky, T., and Levene, H., *Genetics*, **33**, 537 (1948).
[6] Cain, A. J., and Sheppard, P. M., *Heredity*, **4**, 275.

Growth Inhibition in Amphibian Larvæ by 4-Amino Pteroyl Glutamic Acid (Aminopterin)

A number of workers have demonstrated the inhibition of growth in the rat and mouse[1,2], bacteria[3–5], and in the chick[6–8] by means of folic acid antagonists. Seeger *et al.*[5] have shown that 4-amino pteroyl glutamic acid is a powerful antagonist of folic acid by the *Streptococcus fœcalis* R. test, and its toxicity in mammals has been well established.

Karnofsky *et al.*[7] demonstrated quite conclusively that 4-amino pteroyl glutamic acid, as an analogue of folic acid, has the ability to inhibit growth in the chick, and the question arose as to whether this reaction could be found in a cold-blooded vertebrate as well. In this preliminary report, the growth inhibition of amphibian larvæ by 4-amino pteroyl glutamic acid is indicated, particularly in the growth phases in the middle and late larvæ. Studies on inhibition in early development, effects on embryogenesis, and possible reversal effects are to be presented elsewhere at a later date.

Adult *Rana pipiens* were ovulated by pituitary induction and the eggs stripped and fertilized. At the two-cell stage, the eggs were divided into two groups: group *B*, in which the tertiary membranes were left intact, and group *C*, in which the tertiary membranes were removed. Group *A*, serving as controls, consisted of two further series, one with membranes intact, the other with membranes removed from the eggs. The eggs were allowed to develop in pond water at a temperature of 18° ± 0·5° C. Groups *B* and *C* received daily doses of 4-amino pteroyl glutamic acid (aminopterin) (Lab. No. 7–9332 furnished through the courtesy of Dr. E. L. R. Stokstad, Lederle Laboratories Division, American Cyanamid Corp., Pearl River, N.Y.) as follows: 1,000, 500, 100 and 10 μgm. per 100 c.c. of pond water in a single bowl. Because the antagonist forms degradation products after twenty-four hours, daily changes were made of the liquid contents of the bowls in which the animals were kept.

Table 1. Effect of Aminopterin on the Development of Late Anuran Larvæ with Membranes Intact.

Each observation is the mean for 3–5 larvæ; temperature of habitat bowls containing larvæ, 18°±0·5° C.

Stage (Shumway)	Micrograms of aminopterin 1,000	500	100	10	0 (Controls)
	(All measurements expressed in mm.)				
19	6·0	5·9	5·9	5·3	6·0
22	9·9	8·8	8·3	7·8	8·6
24	11·4	10·8	10·8	10·3	10·6
24–25	11·0	10·8	12·0	11·1	12·0
25	11·6	10·6	12·3	11·9	13·1
25+	12·3	10·4	13·4	12·0	14·7

In series *B* (Table 1), the most marked inhibition appears to occur immediately following stages 21–22 [9], at which time the mouth is open and the larvæ begin actual feeding. A dosage of 1,000 μgm. is not a lethal dose for anuran embryos and, further, it does not appear to produce such marked inhibition as, for example, 500 μgm. does for this series.

Table 2. Effect of Aminopterin on the Development of Late Anuran Larvæ with Membranes Removed.

Each observation is the mean for 3–5 larvæ; temperature of habitat bowls containing larvæ, 18°±0·5° C.

Stage (Shumway)	Micrograms of aminopterin 1,000	500	100	10	0 (Controls)
	(All measurements expressed in mm.)				
19	5·5	5·6	5·1	6·1	5·3
22	8·8	8·5	7·5	7·2	8·1
24	10·2	10·5	9·1	10·4	11·4
24–25	10·2	10·5	10·5	11·9	13·3
25	10·2	11·6	10·5	12·4	14·8
25+	dead	dead	9·6	12·0	15·3

Results for series *C* are presented in Table 2. It is presumed that larvæ in this group were in more direct contact with the actions of the antagonist, as the highly selective factors effective within the outer membranes are discounted, since the greater portion of the tertiary membranes were removed. Here both 1,000 μgm. and 500 μgm. represent a lethal dosage for the larvæ. Prior to death, the greatest inhibition of growth occurred in animals given 1,000 μgm.

From these results it appears that 4-amino pteroyl glutamic acid has an inhibiting effect upon the growth of middle and late *R. pipiens* larvæ. The mode of action of this inhibition is not yet known. In the higher vertebrates, 4-amino pteroyl glutamic acid is not an ideal metabolic inhibitor, as a reversal effect cannot always be obtained by administration of folic acid[2,10]. Also, it is difficult to say whether the inhibition of growth observed in experiments employing folic acid antagonists is due to a general interference with the growth of the larvæ or injury to a specific tissue leading to retardation as a whole. The work now in progress is designed to investigate this matter. There are indications that the antagonist interferes with the more actively growing areas, those tissues which grow more rapidly being most affected. The abnormalities produced by graded concentrations of 4-amino pteroyl glutamic acid in the early frog embryo are rather non-specific and have been produced by a variety of experimental procedures. All are believed to interfere with the energy expenditure of the embryo, causing failures in gastrulation, neuralation, as well as in other phases of growth. It is quite likely that the action of the antagonist in this case is of a similar nature. Experiments are now in progress which consider this premise.

R. M. Rosenbaum
J. T. Velardo

Biological Laboratories,
Harvard University,
Cambridge, Mass.
April 29.

[1] Franklin, A. L., Stokstad, E. L. R., and Jukes, T. H., *Proc. Soc. Exp. Biol. Med.*, **67**, 398 (1948).
[2] Philips, F. S., and Thiersch, J. B., *J. Pharm. and Exp. Therap.*, **95**, 303 (1949).
[3] Franklin, A. L., Stokstad, E. L. R., Hoffman, C. E., Belt, M., and Jukes, T. H., *J. Amer. Chem. Soc.*, **71**, 3549 (1949).
[4] Sauberlich, H. E., *Fed. Proc.*, **8**, 247 (1949).
[5] Seeger, O. R., Smith, jun., J. M., and Hultquist, M. E., *J. Amer. Chem. Soc.*, **69**, 2567 (1947).
[6] Franklin, A. L., Stokstad, E. L. R., and Jukes, T. H., *Proc. Soc. Exp. Biol. Med.*, **65**, 368 (1947).
[7] Karnofsky, D. A., Patterson, P. A., and Ridgeway, L. P., *Proc. Soc. Exp. Biol. Med.*, **71**, 447 (1949).
[8] Wagley, P. F., and Morgan, H. R., *Bull. Johns Hopkins Hosp.*, **83**, 275 (1948).
[9] Shumway, W., *Anat. Rec.*, **78**, 139 (1940).
[10] Velardo, J. T. (personal observation).

A Micro-method for the Examination of the Biochemical Activities of Micro-organisms

The large-scale screening of cultures of micro-organisms for biochemical activities is nowadays frequently designed to select organisms which are effective in submerged culture[1]. We have recently developed a technique for the examination of hundreds of cultures for their suitability for surface culture, with particular reference to enzyme formation.

The method consists in growing the organism in a small cylinder containing 0·1 ml. of an agar medium, which is added aseptically from a hot-water jacketed micro-burette. The cylinders rest on a thin polyvinyl chloride sheet in a Petri dish, containing

up to 40 cylinders. The latter, usually porcelain or glass, are conveniently sterilized in glass columns prior to filling. With two operators, 500 cylinders can be filled in an hour. Using spore suspensions, five fungi have been inoculated in one dish, with no cross-infection. Incubation in a humidity chamber is necessary, to prevent drying out of the medium. When the mycelial mat is formed, little drying is observed after ten days incubation, and the growth of twenty different fungi was quite typical and sporulation was not retarded.

For estimating the metabolic products formed, a modification of the agar-plate diffusion technique has been used[2,3]. The plugs of agar inside the cylinders are transferred to a glass sheet by extrusion with a glass rod. For estimating enzyme activity, a suitably buffered 1·5 per cent agar solution containing the substrate is poured on to the plate at 48–50° C. This ensures that a perfect seal is formed around each plug. It is necessary to include salicylanilide in the assay medium, to prevent further growth during the assay. The glass sheet is incubated for twenty-four hours and developed with a suitable reagent. In a typical experiment, five fungi were examined for α-amylase and polygalacturonase, sample plugs being removed and assayed each day for ten days. In the accompanying photograph, two typical plates, for polygalacturonase and α-amylase, are shown with zones, representing a day's samples, and dilutions of a standard enzyme preparation to allow calculation of the enzyme concentrations in the unknowns. This photograph shows that in the case of *Aspergillus flavus oryzæ* (sp.) large amounts of α-amylase are produced, but no polygalacturonase; with *Penicillium chrysogenum* the reverse is apparent.

Other products can be estimated using plain agar plates, and after diffusion development with a suitable reagent, for example, kojic acid, developed with ferric chloride to give red zones around the plug; antibiotics can be assayed by the usual methods. The technique is being used successfully for the screening of cultures of micro-fungi, and by using purified agar and nutrients, the effect of nitrogen source, growth factors, etc., on the biochemical activities of a culture can be readily studied. Full experimental details will be published elsewhere.

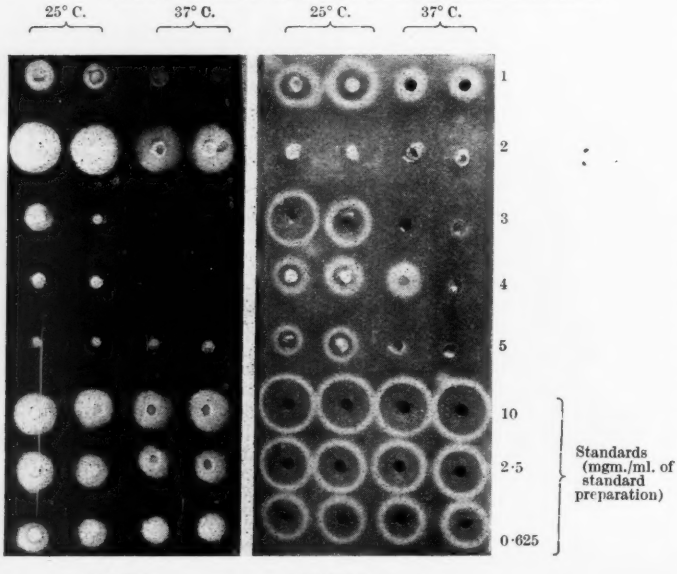
We wish to thank W. W. Reid for his help in this work, and the directors of H. W. Carter and Co. for permission to publish these results.

J. Dingle
G. L. Solomons

Research Department,
H. W. Carter and Co., Ltd.,
Coleford, Glos.
April 26.

[1] Baker, P. B., *Nature*, **163**, 732 (1949).
[2] Reid, W. W., *Nature*, **166**, 569 (1950).
[3] Dingle, J., Reid, W. W., and Solomons, G. L. (in preparation).

Assay of Duplicate Three-day Old Cultures of Micro-fungi, Grown at 25° and 37° C., for α-Amylase and Polygalacturonase



Organisms: (1) *Aspergillus fœtidus* (n.sp.); (2) *Aspergillus flavus-oryzæ*; (3) *Botrytis cinerea*; (4) *Penicillium chrysogenum*, Q.176; (5) *Syncephalastrum cinereum*.

Unicellular Algæ as a Source of Food

Supplies of food are not enough to give the present world population an adequate diet, and population is increasing more rapidly than the output of agriculture. In 1948, Dr. F. N. Woodward (then at the British Commonwealth Scientific Office, Washington) reported that some American scientific workers thought the problem could only be solved by devising non-agricultural methods for producing proteins, fats, carbohydrates, etc. One of the American suggestions was that unicellular green algæ, suitably cultured, might give much higher yields per acre than conventional agricultural crops. Among the algæ suggested were species of *Chlorella* and *Scenedesmus*.

Calculations based on available data, from researches into photosynthesis in which *Chlorella* is widely used as the experimental subject, suggested that it was theoretically feasible to obtain much higher yields per acre from *Chlorella* than from agricultural crops. (One of the assumptions made was that the alga could be grown in shallow ponds.) Experimental work was therefore started at Jealott's Hill to obtain more information. Much remains to be done before the economic possibilities can be accurately assessed; but it is hoped that the present account of the position we have now reached may be of help to others engaged in similar research.

The growth and composition of unicellular algæ are influenced by many factors, most of which are interrelated. Hence, determination of the optimum conditions for the mass culture of these organisms would involve considerable time and effort. Our approach has therefore been somewhat arbitrary, the aim being to devise a technique which would give reasonably high yields of a product with a tolerably constant composition.

This work has been conducted with *Chlorella vulgaris* var. *viridis*; but it is recognized that this may not be the most suitable alga. The diameters of the cells of the strain used in these experiments ranged from 3 to 10 microns. *Chlorella* multiplies by binary fission, and there are four distinct stages in the growth-cycle: a lag phase, an exponential phase, an approximately linear phase, when growth is somewhat less than in the exponential phase, and finally a stationary phase.

The size of the inoculum used in all the cultures described here was equivalent to 5 mgm. of dry matter per litre. The yield of dry matter was considerably increased by eliminating the initial lag phase in growth. This was done by inoculating with cells that were in the exponential growth phase.

At the beginning of these investigations, a nutrient medium recommended by Winokur[1] was used; but it was found that when nitrate nitrogen was replaced by ammoniacal nitrogen, higher yields of dry matter were obtained, and that when ammonium nitrate was used the organism preferentially absorbed the ammonium ion. Accordingly, in all subsequent experiments ammoniacal nitrogen was used. The *p*H of the medium was initially adjusted to 6·0, and throughout the incubation period it was readjusted twice daily. The optimum temperature is about 25° C., growth being much poorer at 20° C. and 30° C. In all experiments carbon dioxide has been supplied, chiefly for convenience, as a 5 per cent carbon dioxide – 95 per cent air mixture. Only 15 per cent of the carbon dioxide supplied escaped to the atmosphere, that is, about 85 per cent was used by the organism.

The cultures were illuminated by 'daylight' fluorescent tubes. Very good growth was obtained at 1,300 foot-candles. It was appreciated that artificial illumination might be quite uneconomic, but it was essential to have a constant light source when other factors were being studied. Tests showed that if the cultures were illuminated for 8 hr. and kept in the dark for 16 hr. each day, yield per unit of light supplied was as high as with continuous illumination; that is, the cells did not appear to go off exponential growth in the dark period. It is therefore theoretically possible to use daylight and get high yields. In southern England, illumination (not direct sunlight) averages about 1,250 foot-candles for 8 hr. a day for six months of the year and about 750 foot-candles for another two months. In lower latitudes, conditions might be more favourable.

Agitation was found necessary for maximum yields. In our experiments in tubes, an intermittent air 'blast' was used.

In the earlier experiments, the organism was cultured in flasks and in narrow cylinders. In a later experiment it was cultured in a battery of tubes 4½ ft. long × 2¾ in. diameter with continuous lighting (1,300 foot-candles). When harvesting every sixth day over a period of months, the average yield was 1·9 gm. dry matter/litre/6 days. Later, a batch process was run in these tubes, the idea being to maintain a fairly dense population growing exponentially. Each day, three-quarters of the liquid in each tube was run off, the cells removed and the liquor, suitably adjusted with nutrient and water, returned. The average yield per litre harvested was 0·7 gm./day.

Harvesting by ordinary filtration proved difficult, as the cells bed down tightly; but centrifuging is quite satisfactory. The product was freeze-dried and its composition has been fairly constant; namely, 8 per cent nitrogen (47 per cent 'true' protein), 1–5 per cent ether extract and 7·5 per cent ash. It is deep green in colour and contains more than 1,200 p.p.m. of β-carotene.

The amount of 'fat' extracted by ether alone was between 1 and 5 per cent; but ether extraction after dilute acid hydrolysis or straight methanol extraction removed about 20–25 per cent of the material. The nature of this is being investigated, as are the amino-acid content of the protein and the constituents of the 'carbohydrate' fraction.

The product might be used as food for animals or even humans, or as a substrate for growing other organisms. Through the kind co-operation of Dr. Kathleen M. Henry, feeding tests on rats were conducted at the National Institute for Research in Dairying. The diet contained 17 per cent freeze-dried *Chlorella* cells, and the 'protein efficiency ratio', though less than that of skimmed milk, was significantly higher than that of dried brewers' yeast or groundnut meal.

Our work is being continued and will be reported in detail elsewhere at a later date.

M. J. GEOGHEGAN

Jealott's Hill Research Station,
Imperial Chemical Industries, Ltd.,
Bracknell, Berks.

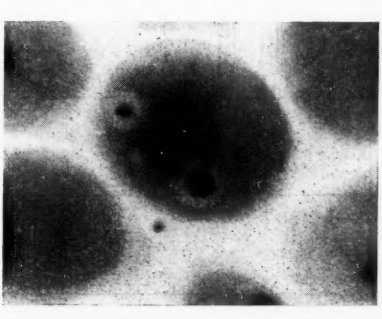
June 1.

[1] Winokur, M., *Amer. J. Bot.*, **35**, 118 (1948).

Chromosomes in Yeasts

CENTROSOMES and chromosomes were described in our control strain of yeast some four years ago[1]. At that time we had to depend on camera lucida illustrations, owing to lack of facilities for photomicrography. Winge and Roberts[2], while agreeing with our criticisms of Lindegren's[3] views on yeast cytology, comment: "The experience of the senior author in searching for the difficultly observable chromosomes in yeasts have not led to a resumption of cytological investigations". In a recent publication, they[4] dispute our claim of induction of polyploidy and state that technical difficulties should have precluded satisfactory chromosome counts. Lindegren and Rafalko[5], on the other hand, try to interpret the bodies identified by us as chromosomes as centrioles, but do not extend it to the bodies identified by us as the centrioles.

Yeast chromosomes are neither too small nor too difficult to identify, as is clear from the accompanying photomicrograph (cf. ref. 1, Fig. 1, p. 480) showing



Photograph from a smear of an aerobic liquid culture fixed in Carnoy and stained with iron hæmatoxylin. × *c.* 5,750

an early metaphase condition. The two chromosomes are orientated on a spindle at the poles of which can be seen the centrioles with the centrospheres.

Photomicrographs illustrating induction of polyploidy and the cytological behaviour of such induced autotetraploids are awaiting publication elsewhere[6].

M. K. Subramaniam
Cytogenetics Laboratory,
Department of Biochemistry,
Indian Institute of Science,
Bangalore. Feb. 2.

[1] Ranganathan, B., and Subramaniam, M. K., *Sci. and Cult.*, **12**, 478 (1947).
[2] Winge, O., and Roberts, C., *C.R. Lab. Carlsberg*, **24**, 263 (1948).
[3] Lindegren, C. C., *Mycologia*, **37**, 767 (1945).
[4] Winge, O., and Roberts, C., *C.R. Lab. Carlsberg*, **25**, 35 (1950).
[5] Lindegren, C. C., and Rafalko, M. M., *Exp. Cell. Res.*, **1**, 169 (1950).
[6] Subramaniam, M. K., *Cellule* (in the press).

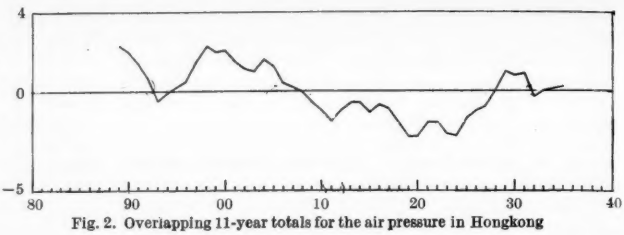


Fig. 2. Overlapping 11-year totals for the air pressure in Hongkong

Recent Climatic Variations in Indonesia

In the past few years, interest in recent climatic changes has been growing. Especially in moderate and high latitudes of the northern hemisphere, climatic variations for several decades have been studied. The most striking phenomenon is the rise in temperature, especially that of winter temperatures, up to about 1940[1]. Petterssen[1] showed that this climatic change in moderate and high northern latitudes is connected with a variation of circulation. A similar rise in temperature, although much less marked, has occurred in certain equatorial regions[2]; further, it was found that about the year 1921, or at any rate between 1920 and 1939, the rate of rise of temperature increased rather suddenly.

To show a change in circulation with the aid of pressure and wind observations is much more difficult for equatorial regions than elsewhere, due to the smaller differences in pressure and wind. It seems to be possible, however, to draw certain conclusions on the climatic variation in equatorial regions by considering the precipitation records of Indonesia, where regular measurements of this climatological element have been taken from 1879 onward. In order to omit, so far as possible, the influence of the normal variation in sunspot numbers, we took overlapping eleven-year totals of the amounts of precipitation for West Java, Central Java, East Java (each being a mean of twenty representative stations), and for about thirty stations in the other islands of Indonesia.

Considering these eleven-year totals, it appeared possible to distinguish two groups, each of about ten stations (including the three provinces of Java), the groups showing an anti-parallel course. In the first group, the eleven-year totals for rainfall show a maximum between 1920 and 1930, whereas the stations of the second group show a minimum during this period, which is the very period during which the rate of temperature rise increased. The stations of the first group are crowded along the equator, whereas those of the second group consist of stations situated in the southern hemisphere between, say, lat. 2° and 10° S.

The difference between the maximum and the minimum eleven-year totals for precipitation may in each group amount to as much as 20 per cent of the mean eleven-year total itself. This suggests that we have to deal with an important climatic fluctuation. In Fig. 1, Pontianak, situated on the equator, is an example of the first group, whereas West Java belongs to the second group. The correlation coefficient calculated from the 11-year totals of the precipitation at Pontianak and in West Java over the period 1879–1940 is −0·75. It appears from Fig. 1, however, that during the first ten years of this period the relation existing between the two precipitations is different from that during the remainder of that period.

If we confine ourselves to the eleven-year totals from 1889 onward, we find r to be −0·89, with a standard error of 0·03. It seems clear from these figures, and also from their graphical representation, that we are dealing here with a strong interdependence between the climatic variations in Pontianak and those in West Java. This interdependence may be the outcome of the southward displacement of the 'intertropic zone of convergence' in the autumn and winter of the northern hemisphere, and of its northward displacement in the spring; for these displacements manifest themselves in the amounts of

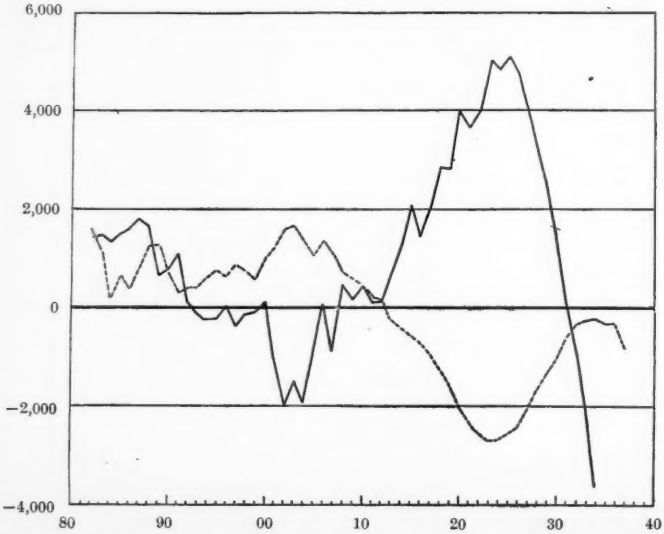


Fig. 1. Overlapping 11-year total for the precipitation in Pontianak (full line) and West Java (broken line)

precipitation, the rainfall being especially abundant during the passing of the convergence.

To show further proof of this influence of the inter-tropic zone of convergence, the 11-year totals for the pressure at Hongkong are given in Fig. 2. This quantity may be regarded as being representative of the intensity of the Siberian pressure maximum, and therefore to be determining very largely the convergence displacements over Indonesia. The connexion already follows from the figures. High pressure at Hongkong is accompanied by a maximum of precipitation in West Java, and a minimum at Pontianak. The correlation coefficient between the 11-year totals for the pressure at Hongkong and the 11-year totals for the precipitation in West Java is + 0·55 with a standard error of 0·10.

These results show clearly that variations of circulation occur not only in moderate latitudes, but also in the tropics.

We intend to discuss elsewhere in some detail the problem of recent climatic variations in Indonesia.

K. J. TEN HOOPEN
F. H. SCHMIDT

Meteorological and Geophysical Service
of Indonesia, Djakarta. April 18.

[1] Various authors in *Geografiska Annaler*, **31** (1949).
[2] De Boer, Euwe, *Verhand. Meteor. en Geophys. Dienst, Batavia* (1949).

The Lithium-7 Nucleus

OBSERVATIONS by Rose and Wilson[1] in the reaction $^{10}B(n,\alpha')^{7*}Li(\gamma)^{7}Li$ and by Littauer[2] in $^{7}Li(p,p')^{7*}Li(\gamma)^{7}Li$ have shown that the 480-keV. gamma ray is emitted isotropically in these reactions. In the former experiment the yield of radiation was measured relative to the direction of emission of the short-range alpha particle. In the latter case it was determined with respect to the incident proton. These observations constitute strong evidence that the spin of the 480-keV. state is $\frac{1}{2}$, although in both cases the lack of a correlation could arise from other special circumstances. Accordingly, we have looked for a correlation between the short-range proton and the gamma-ray in the $^{6}Li(d,p')^{7*}Li(\gamma)^{7}Li$ reaction.

A thin target of lithium-6, prepared in a mass spectrograph[3] and maintained constantly under vacuum, was bombarded with 0·80 MeV. deuterons from an electrostatic generator. The protons and the gamma rays from the reaction were detected with suitable scintillation counters, and successive proton-gamma emissions were observed by operating the counters in coincidence. The particle detector was placed so as to observe protons emitted in the direction of the incident beam. The gamma-ray counter was operated at angles varying between 35° and 145°. Despite the relatively pure lithium-6 target and considerable shielding, the accidental coincidence-rate was high, with resolving times of somewhat more than 10^{-8} sec., when beam currents were used large enough to make the rate of detection of real coincidences reasonable. Provision was made therefore for constantly monitoring the accidental coincidence-rate. This was desirable also because of fluctuations in the counting-rate arising from the unsteady source[4].

The reaction itself was monitored by observing the single-channel counting-rate of the fixed proton counter, and also by means of a beam current integrator. The single-channel counting-rate from the gamma-ray counter was observed but was not a true measure of the yield of radiation of the reaction under study, because of the presence of other gamma-rays resulting from the deuteron bombardment of lithium-6 and target impurities.

The proton-gamma coincidence-rate was measured at nine settings of the gamma counter. Upward of 2,000 coincidences were obtained at each angle. The coincidence-rate per proton, corrected for small variations in the distance of the gamma counter, varied in a random fashion within the statistical limits of the measurements, which were between 5 and 10 per cent. A least-square analysis of these data into a cosine series gives a coefficient of $\cos^2\theta$ which is less than 3 per cent of the isotropic term. Because of the low recoil velocity of the lithium-7 nucleus in this experimental arrangement (9×10^{-3} c), the Doppler effect produces a negligible correction. A check was made on the amount of gamma-ray scattering present and the reality of the observed coincidences by placing lead absorbers in front of the gamma-ray detector at several gamma-angles. The results verified the nature of the coincidences, and indicated that the effects of scattering were small and not noticeably dependent on the angle.

This lithium-6 reaction differs from the boron-10 reaction investigated by Rose and Wilson[1], in that the compound nucleus beryllium-8 is not formed entirely by s-wave capture[5]. In the present experimental arrangement, however, the complexity of the correlation will be determined primarily by the properties of the excited state in lithium-7 and the subsequent radiation. The failure to detect a correlation in this experiment, therefore, is consistent with the assignment of $I = \frac{1}{2}$ to the 480-keV. state. Additional experimental details and a theoretical discussion will appear elsewhere.

C. M. CLASS
S. S. HANNA

Department of Physics,
Johns Hopkins University,
Baltimore, Maryland.
April 21.

[1] Rose, B., and Wilson, A. R. W., *Phys. Rev.*, **78**, 68 (1950).
[2] Littauer, R. M., *Proc. Phys. Soc.*, A, **63**, 294 (1950).
[3] This instrument, built specifically for separating the lithium isotopes, follows the design of Smythe, Rumbaugh and West, *Phys. Rev.*, **45**, 724 (1934).
[4] Littauer, R. M., *Rev. Sci. Inst.*, **21**, 750 (1950).
[5] Whaling, W., and Bonner, T. W., *Phys. Rev.*, **79**, 258 (1950). Krone, Hanna and Inglis, *Phys. Rev.*, **80**, 603 (1950).

31-keV. Excited State of Aluminium-28

A RECENT accurate magnetic analysis of the proton groups from the reaction $^{27}Al(d,p)^{28}Al$ by Strait and his collaborators[1] showed the presence of an excited state in the residual nucleus of aluminium-28 at 31 ± 2 keV.

The existence of such a low-lying level in a light nucleus is of considerable interest. Predictions of the positions of the lowest nuclear levels have been made by considering the rotation of the nucleus as a whole[2,3], and the excitation energies thus calculated show reasonable agreement with the levels previously experimentally determined. However, the lowest rotational level for the aluminium-28 nucleus would be expected to have an excitation energy above 100 keV., and a level at 31 keV. could not be a simple rotational level. It is also unlikely that such a level could be explained on the basis of the nuclear shell model recently discussed by Mayer[4] as a splitting of the ground state due to spin-orbit interaction. In this connexion a knowledge of the multipole order of any gamma-ray transition between this level and the ground state would be of value.

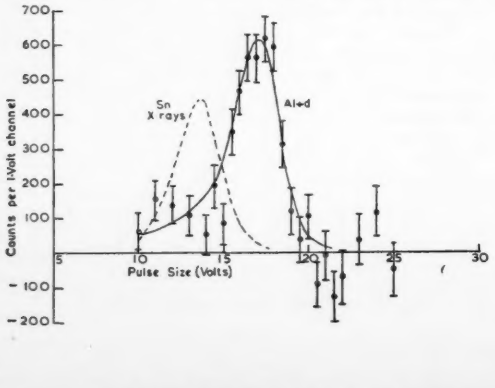
In view of the particular interest of this level, a search has been made for gamma-radiation resulting from its de-excitation. An aluminium target was bombarded with deuterons with an energy of 700 keV. The radiation was detected at 90° to the deuteron beam with a proportional counter. The counter, 4 in. in diameter, was fitted with 'field tubes'[5] to eliminate end effects, and filled with argon and methane to partial pressures of 3 atmospheres and 15 cm. respectively. The counter was screened with 3 in. of lead, and the β-particles from the decay of aluminium-28 and nitrogen-13 (produced from carbon contamination of the target) were prevented from reaching the counter by polythene absorbers and the field of a strong permanent magnet.

Radiation of an energy of $31{\cdot}4 \pm 1{\cdot}0$ keV. was detected and presumed to be due to the de-excitation of the 31-keV. level in aluminium-28. The peak counting-rate was about one quarter the background rate. This background was due to gamma-radiation and neutrons both from the target and from reactions produced by that part of the beam which struck the walls of the resolving chamber. The background not originating at the target was variable, and to minimize this variation it was necessary to keep the beam current and focus particularly steady during counts. Successive counts were made with aluminium and lead absorbers of equal surface density at each setting of the pulse analyser. The difference between these pairs of counts is plotted in the accompanying graph as a function of pulse amplitude. The spectrum of the *K* X-rays of tin is also shown. The energy of the gamma-ray was determined by comparison with these X-rays and those of barium, produced by proton bombardment of targets of metallic tin and barium chloride. Absorption measurements of the gamma-radiation were also made and were consistent with the energy thus determined.

The radiation was also detected by a scintillation method. A thallium-activated sodium iodide crystal 1 cm. square and 1 mm. thick was mounted on an *E.M.I.* type 5311 photomultiplier and screened with 3 in. of lead. The β-particles were absorbed with polythene. Although the background was less than that experienced with the counter, the resolution of the crystal was inferior and the counter was, therefore, used for determining the energy of the gamma-ray.

From the calculated efficiency of the counter and on the assumption that the radiation is isotropic, the yield from a thick aluminium target at a bombarding energy of 700 keV. was estimated to be $1{\cdot}1 \pm 0{\cdot}5 \times 10^3$ γ per microcoulomb.

The low-energy electrons from this reaction have been examined with a 180° magnetic spectrometer.



No internal conversion electrons corresponding to the 31-keV. gamma-ray have been detected: from the efficiency of the spectrometer it is estimated that the internal conversion coefficient α_K is less than 2. Such a value suggests that the transition to the ground state is electric dipole. A more precise measurement is to be made.

R. D. Smith
R. A. Anderson
Department of Natural Philosophy,
University of Glasgow, W.2.
July 25.

[1] Strait, E. N., Patter, D. M., Buechner, W. W., and Sperduto, A., *Phys. Rev.*, **81**, 747 (1951).
[2] Guggenheimer, K. M., *Proc. Roy. Soc.*, A, **181**, 169 (1942).
[3] Preiswerk, P., *Helv. Phys. Acta*, **23** (No. 1–2), 7 (1950).
[4] Mayer, M. G., *Phys. Rev.*, **78**, 16 (1950).
[5] Cockcroft, A. L., and Curran, S. C., *Rev. Sci. Instr.*, **22**, 37 (1951).

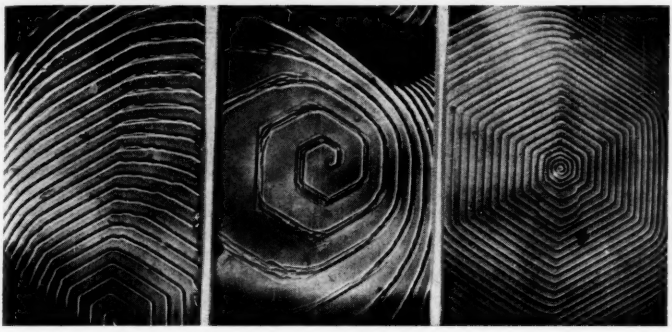
Growth Spirals on Carborundum Crystals

The observation of growth spirals on carborundum crystals has been reported earlier[1]. These growth spirals can be divided into two classes: (1) those in which the step-height between the successive edges of the spiral is equal to the height of a unit cell; and (2) those in which the step-height is a multiple of it. The latter type of multi-stepped spiral will result from a dislocation the strength of which is a multiple of the repetition period, the Burger's vector being a multiple of the height of the unit cell. Such spirals have been found to originate at a large hole (see Fig. 2); they have a much higher optical visibility because of the relatively large step-height, being therefore easily observed with a microscope using bright-field illumination. Of the numerous spirals of this kind seen, two typical examples are shown here. The steps of these spirals can break up into their component steps under certain conditions. In Fig. 1, showing only one half of the spiral, the various components advance together in different directions for some twelve turns, after which they break up into five or six close branches. In Fig. 2 is illustrated a case where the dissociation takes place quite near the centre and growth can be regarded as taking place from the multiple dislocations.

Carborundum[2] is a polytypic crystal. In the hexagonal types or the rhombohedral types referred to the hexagonal axes, the number of layers necessary for the arrangement to repeat itself is also the number of 'formula weights' in the unit cell. However, in the actual rhombohedral unit cell, the number of formula weights is one-third of the total number of layers included within the *c*-axis. The measurement of the step-height of the growth-spirals on the different types should be able to show this point.

On the hexagonal type II crystal (6*H* in Ramsdell's notation) the step-height measurements have already been given[1] and shown to be equal to the height of the unit cell ($c = 15$ A.). Further measurements of the step-height, by the application of multiple-beam interferometry on the growth spirals on the different rhombohedral types, are now reported here.

On a type I crystal (15*R* in Ramsdell's notation) the measured step-height is 12 ± 2 A. This is equal to one-third of the lattice parameter *c* of the unit cell referred to the hexagonal axes, and is in agreement within experimental error with the predicted X-ray value of $a_{rh} = 13$ A. of the rhombohedral cell. The visibility of this growth spiral is consistent with this measurement of step-height.



(1) (2) (3)

On a type VI crystal (33*R* in Ramsdell's notation), the measured step-height is 28 ± 2 A., which again is very close to a_{rh} of the rhombohedral cell, and within experimental error is identical with it.

Fig. 3 shows a hexagonal spiral with step-height nearly 130 A., and it may be concluded that it is one of the types with giant unit cells. If a_{rh} is indeed equal to the step-height of 130 A., then the classification is probably 159*R*.

Thus, it seems established that the step-height is equal to the height of the actual unit cell. This gives another physical confirmation of the existence of the X-ray unit cell.

I wish to express my thanks to Prof. S. Tolansky for his interest in the work, and to the British Council for the award of a scholarship.

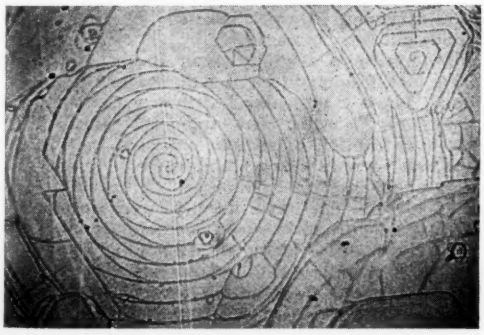
AJIT RAM VERMA

Royal Holloway College,
(University of London),
Englefield Green,
Surrey. June 21.

[1] Verma, A. R., *Nature*, **167**, 939 (1951).
[2] Ramsdell, L. S., *Amer. Min.*, **32**, 64 (1947).

Growth Mechanism of Carborundum Crystals

GROWTH spirals, as predicted by F. C. Frank's theory[1] on crystal growth, have been observed on the *c*(0001) faces of carborundum by Ajit Ram Verma[2] and by S. Amelinckx[3]. The steps between successive turns, as stated by Frank, are exactly one unit cell high. This seems, in fact, to be true in many cases, although steps of several unit cells high are not exceptions.



We now have evidence that layers thinner than one unit cell are formed in certain circumstances.

The photograph reproduced herewith shows a growth pattern on a *c*(0001) face of a carborundum crystal. The technique of observation was the same as the one used previously. By means of Weissenberg photographs about an α-axis, we found the crystal to be of the type 6*H* (formerly type II)[4]. The structure of this type of carborundum can be considered as being made up of superimposed three-layered lamellæ, each lamella rotated 180° to that immediately below it[5]. The unit cell contains two such lamellæ, and each of them has trigonal symmetry about the *c*-axis.

The accompanying photograph shows a double growth-spiral. The two components are generated by the same dislocation end; both have trigonal symmetry as shown by their radial growth-velocity, but their orientation differs by 180°. This shows that two successive sheets are not equivalent.

The average height of a step between successive loops of the spiral was measured by means of multiple beam interferometry[6] and found to be 7 ± 2 A., that is, the height of one three-layered lamella (or half a unit cell).

The most logical interpretation of this pattern would appear to be that these two spirals are due to the growth of each lamella separately. Consequently carborundum crystals (of type 6*H*) seem to grow, at least in certain circumstances, not by unit cells but by three-layered lamellæ. Probably similar conclusions will hold for the growth of the other types of silicon carbide; they could provide a basis for the explanation of the existence of the numerous types of carborundum which are known.

A more detailed account of this work is being published elsewhere.

I am grateful to Prof. W. Dekeyser for continuous interest and encouragement. This work is part of a research scheme supported by the Centre National Belge de Chimie Physique Moléculaire, to which I am indebted for a research fellowship. The carborundum samples were kindly provided by S.E.C.E.M.A.E.U. (Usine de la Bathie, France).

S. AMELINCKX

Crystallographic Laboratory,
Geological Institute,
University of Ghent. July 15.

[1] Frank, F. C., Farad. Soc. Discuss. Crystal Growth, No. 5 (1949).
[2] Ajit Ram Verma, *Nature*, **167**, 939 (1951).
[3] Amelinckx, S., *Nature*, **167**, 940 (1951).
[4] Ramsdell, L. S., *Amer. Min.*, **32**, 64 (1947).
[5] Lundquist, D., *Acta Chem. Scand.*, **2**, 177 (1948).
[6] Tolansky, S., "Multiple Beam Interferometry of Surfaces and Films" (Oxford Univ. Press, 1948).

Crystal Structure of Ergine

ERGINE, $C_{16}H_{17}ON_3$, the amide of lysergic acid, is the simplest of the ergot alkaloids. It forms salts with hydrochloric and hydrobromic acids, and crystals of these were kindly put at our disposal by Prof. A. Stoll, of Basle. Both salts crystallize in elongated colourless plates, which are optically

biaxial positive with the plane of the optic axes perpendicular to the *b*-axis.

Exposures were made of the (*h*0*l*), (*h*1*l*), (0*kl*) and (1*kl*) zones of both compounds with a Weissenberg camera, using copper $K\alpha$ radiation.

Oscillation photographs around the three axes were also taken. The following results were obtained from these photographs:

B·HCl:	$a = 9{\cdot}44° \pm 0{\cdot}02$ A.	*B*·HBr:	$a = 9{\cdot}60° \pm 0{\cdot}02$ A.
	$b = 5{\cdot}74 \pm 0{\cdot}01$ A.		$b = 5{\cdot}74 \pm 0{\cdot}01$ A.
	$c = 13{\cdot}60 \pm 0{\cdot}05$ A.		$c = 13{\cdot}79 \pm 0{\cdot}05$ A.
	$\beta = 91{\cdot}2°$		$\beta = 91{\cdot}2°$

The compounds proved to be isomorphous, space group $P2_1$. The measured densities of 1·40 and 1·56 for hydrochloride and hydrobromide respectively indicated two molecules in the unit cell. The intensities of the (*h*0*l*) and (0*kl*) reflexions of both compounds were estimated visually, and corrected for the Lorentz polarization factor. The F^2-values were brought on to an absolute scale, using Wilson's method[1]. Patterson maps were prepared for both compounds along [100] and [010], using *X-RAC* (calculation on *X-RAC* under contract No. N6onr-26916, T.O. 16 with the Office of Naval Research). The co-ordinates of the halogen atoms were found from these maps.

In addition, a Patterson map was prepared, using as coefficients $(F^2_{B\cdot HB} - F^2_{B\cdot HCl})$. These maps show only the vectors between atoms of weight (Br—Cl), and between these atoms and the lighter atoms. Vectors between the lighter atoms only do not appear. This Patterson map was drawn twice with its origin at each of the two halogen positions. These two drawings were superimposed and points were marked where regions of high vector density coincided[2], as is shown in Fig. 1.

Signs of the (*h*0*l*) coefficients were calculated from the halogen contributions using the isomorphous rule. Electron density maps on (010) prepared on *X-RAC* for both compounds showed the molecule clearly resolved. By successive Fourier approximations, and using the criterion of non-negativity of the background on *X-RAC*[3], the (010) projection was refined to give Fig. 2, which is essentially the same as Fig. 1.

The chemical formula proposed by Jacobs, Craig and collaborators[4], with an indole group coupled with two non-aromatic rings, is confirmed. Interpretation and refinement of an electron density map on (100) is now in progress.

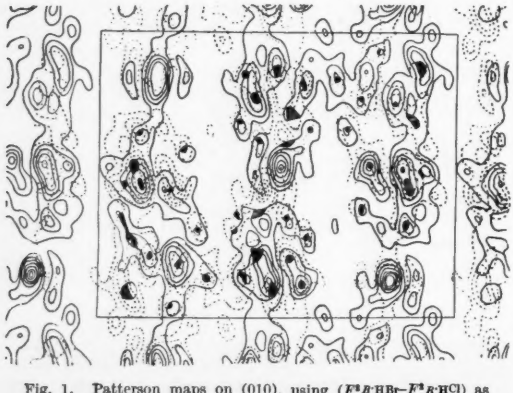


Fig. 1. Patterson maps on (010), using $(F^2_{B\cdot HBr} - F^2_{B\cdot HCl})$ as coefficients. Solid lines with origin at halogen position upper left corner, dashed lines with origin at halogen position lower right corner. Contour lines on arbitrary scale, regions of coincidence marked black

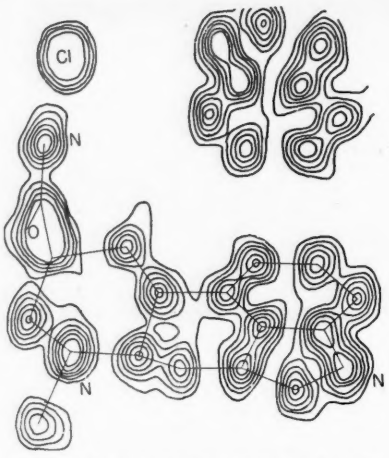


Fig. 2. Part of final electron density projected on (010) of *B*·HCl, showing the molecule. Contour lines on arbitrary scale

We wish to express our gratitude to the Research Corporation, Lilly Research Laboratories, and the Office of Naval Research, for support on the programme of which this investigation is a part.

J. L. De Vries*
R. Pepinsky

Pennsylvania State College.
April 20.

* Eli Lilly Research Fellow.

[1] Wilson, A. J., *Nature*, **150**, 152 (1942).
[2] Beevers, C., and Robertson, J. H., *Acta Cryst.*, **3**, 164 (1950).
[3] Eiland, P. F., and Pepinsky, R., *Acta Cryst.*, **3**, 160 (1950).
[4] Craig, Gould and Jacobs, *J. Biol. Chem.*, **125**, 289 (1938). Jacobs and Craig, *J. Amer. Chem. Soc.*, **60**, 1101 (1938). See also Henry, T., "Plant Alkaloids", p. 528 (Blakiston Co., Philadelphia, 1949).

Age of Tektites

An investigation has been made of the argon content of tektites utilizing the mass-spectrometric isotopic-dilution technique in an attempt to find a clue to the origin of these supposedly meteoric glasses[1]. Previous investigations have shown that the bubbles frequently present in tektites have a gas pressure of less than 10^{-3} atmosphere[2], and that the total argon content of the tektites is below the limits of detection of the ordinary methods of gas analysis[3]. These results show that, from the point of view of age determination of these materials by the argon method, diffusion is negligible.

Tektite samples weighing about 10 gm. each were broken into fragments having dimensions of about 3 mm. These fragments, together with a known quantity of 97·5 per cent argon-38, prepared by neutron irradiation of sodium chloride, were introduced in a vacuum into a stainless-steel system containing about 30 gm. of outgassed sodium hydroxide flux at 400° C. The gases obtained were purified by passage through cupric oxide, a liquid-air trap and a calcium furnace. Finally, the remaining gases were adsorbed on activated charcoal, transferred to a mass spectrometer and their argon isotopic composition determined.

Two experiments were made with the so-called 'gas-rich' tektites from the Philippines and one with an australite. The Philippine tektites came from a Mid-Pleistocene deposit and the australites from a 'practically recent' deposit. The K_2O content given in the literature for these types of tektites ranges between 2 and 2·8 per cent. Dr. O. Joensuu, of the Department of Geology in the University of Chicago, has kindly made a spectroscopic determination of the potassium content of our samples. We have used his results in our calculations.

The results are shown in the accompanying table. The ages obtained are based on a value of $1·33 \times 10^9$ years for the half-life of krypton-40, a value of 7·92 for the ratio of decay to calcium as compared to the decay to argon, and a value of 0·0119 per cent for the abundance of potassium-40. The amounts of argon obtained were so small as to preclude measurement of the argon-36 peak to determine whether the argon-40 was of radiogenic or atmospheric origin. Thus, to set upper limits to the ages of the tektites, we have assumed that all the argon-40 measured was radiogenic. Since experiments run without tektites present give amounts of argon-40 comparable to that obtained from the tektites, it seems probable that the actual age of the tektites is less than the ages quoted.

ARGON CONTENT AND THE AGE OF TEKTITES

	Philippinite		Australite
	1	2	3
Wt. of sample	5·66 gm.	8·80 gm.	12·27 gm.
Potassium (per cent)	1·70 ± 0·2	2·16 ± 0·2	1·99 ± 0·2
Argon-40 per gm. potassium	$0·282 \times 10^{-3}$ c.c.	$0·0403 \times 10^{-3}$ c.c.	$0·104 \times 10^{-3}$ c.c.
Argon-40 per gm. potassium expected for 2×10^9 year age	$13·7 \times 10^{-3}$ c.c.	$13·7 \times 10^{-3}$ c.c.	$13·7 \times 10^{-3}$ c.c.
Max. age (yr.)	$< 73 \times 10^6$	$< 10 \times 10^6$	$< 32 \times 10^6$

The results show that the tektites are definitely much younger than the solar system, and also that they are much younger than the ordinary meteorites which have been dated by Paneth by means of their helium content[5].

We wish to express our thanks to Dr. Otley Beyer, Manila, Philippines, for supplying philippinites from Santa Mesa Site, Rizal Province, and to Sir Kerr Grant, University of Adelaide, and to the Museum of South Australia for supplying the australites used in this investigation.

HANS E. SUESS
RICHARD J. HAYDEN
MARK G. INGHRAM

Institute for Nuclear Studies,
University of Chicago,
and
Argonne National Laboratory,
Chicago, Illinois.
April 25.

[1] See, for example, Paneth, F. A., Halley Lecture (1940).
[2] Suess, H. E., paper at the Washington Meeting, American Geol. Soc., Nov. 1950.
[3] Suess, H. E., *Acta. Geochem. et Cosmochem.* (to be published).
[4] Inghram, M. G., Brown, Harrison, Patterson, C., and Hess, D. C., *Phys. Rev.*, **80**, 916 (1950). Sawyer, G. A., and Wiedenbeck, M. L., *Phys. Rev.*, **79**, 490 (1950). Houtermans, F., Harel, O., and Heintze, J., *Z. Phys.*, **128**, 657 (1950).
[5] Paneth, F. A., *Nature*, **149**, 235 (1942).

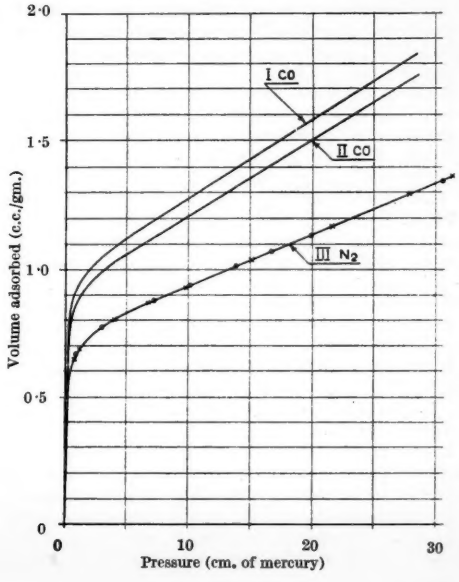
Influence of a Chemisorbed Film on Subsequent Physical Adsorption Processes

Stone and Tiley[1] have reported that the presence of a chemisorbed film of carbon monoxide reduces the low-temperature physical adsorption of krypton on a copper oxide catalyst. This observation is of particular interest, because the accepted method[2] of estimating the area of free metal in a mixed surface involves the assumptions that, at low temperatures, carbon monoxide is initially chemisorbed only on the metal surface, and afterwards physically adsorbed over the whole surface; and that the chemisorbed layer and the bare non-metallic surface have the same adsorption characteristics.

The experimental results shown in the accompanying graph were obtained with an alkali-promoted iron catalyst (as used for the Fischer–Tropsch synthesis), reduced at 450° C. in hydrogen, and degassed at 450° C. for two hours. Similar curves were obtained for two other preparations of the same type of catalyst. The sequence of operations was: (*a*) adsorption of nitrogen at − 195° C. (curve III, ⊙); (*b*) evacuation at 450° C. for half an hour, the evacuation proceeding as the temperature was increased; (*c*) adsorption of carbon monoxide at − 195° C. (curve I); (*d*) desorption of carbon monoxide at − 78° C. for half an hour, at a pressure of 10^{-4} mm. of mercury; (*e*) adsorption of carbon monoxide at − 195° C. (curve II); (*f*) desorption of carbon monoxide exactly as in (*d*); (*g*) adsorption of nitrogen at − 195° C. (curve III, ×).

The presence on the catalyst surface of an amount of strongly chemisorbed carbon monoxide corresponding to the difference between curves I and II is therefore without effect on the subsequent physical adsorption of nitrogen. For the three samples of catalyst tested, the fractions of the surface covered by chemisorbed carbon monoxide were 6·5, 11·6 and 21·5 per cent; in each case the presence of the chemisorbed layer had no effect on the subsequent adsorption of nitrogen.

A possible explanation of the curves in the graph, and of the difference between these observations and



those of Stone and Tiley, is that two different 'chemisorbed' states are involved. In one case the adsorbed molecule may be completely incorporated in the surface with loss of its individual characteristics, so that the perturbation of the original averaged surface field may not be sufficient to have any appreciable influence at the distances of purely physical attraction. It is this type of chemisorption which may be expected in the case of carbon monoxide to occur on clean metallic areas at fairly low coverages, and is represented by the difference between curves I and II. In the second case, the adsorbed molecule may remain distinct from the surface, to which it may be attached by a weak semi-polar bond, and so retain its individual character. In this case the adsorbed molecule behaves as a fresh adsorption centre, the potential at which will certainly differ from the original. This type of carbon monoxide adsorption will probably take place at high coverages on metallic surfaces, and at all coverages on oxides, carbides[3] and nitrides; it approximates to the difference between curves II and III.

A detailed experimental and theoretical investigation is in progress.

This work forms part of the programme of the Fuel Research Board and is published by permission of the director of fuel research, Dr. A. Parker.

A. S. Joy
T. A. Dorling

Fuel Research Station,
Greenwich,
London, S.E.10.
July 3.

[1] Stone and Tiley, *Nature*, **167**, 654 (1951).
[2] Emmett and Brunauer, *J. Amer. Chem. Soc.*, **59**, 1553 (1937).
[3] Podgurski, Kummer, De Witt and Emmett, *J. Amer. Chem. Soc.*, **72**, 5382 (1950).

The results of Joy and Dorling are not altogether surprising, and their suggested explanation is generally in agreement with our views. There are, however, two points of interest.

First, it does not seem in accord with the reported heats of adsorption to refer to carbon monoxide on an iron catalyst as being "strongly chemisorbed" in contrast to the "weak" chemisorption on cuprous oxide. The initial heat of carbon monoxide on iron is approximately 25 k.cal./mole[1], whereas on cuprous oxide it is 21 k.cal./mole[2]. Moreover, after carbon monoxide adsorption at 20° C., prior to the krypton adsorption, we evacuated at a pressure of less than 10^{-4} mm. of mercury for 1 hour at room temperature, thus removing all gas adsorbed with a heat less than 18 k.cal., whereas Joy and Dorling pump off at − 78° C., removing only the gas with a heat less than 12 k.cal. (These are only approximate heat values.) The question of strength of the chemisorbed bond is therefore not immediately significant.

The difference between these two cases surely lies in the nature of the chemisorbed state and its relationship to the nature of the substrate. In so far as carbon monoxide is held on a metallic surface by a form of bonding which is essentially metallic, then the chemisorbed film may be considered as extending the surface of the metal, and no profound modification of the van der Waals adsorption potential occurs. With carbon monoxide on cuprous oxide, the adsorbate molecule is held by a covalent bond to a (largely) ionic surface, with a consequent increase in adsorption potential. It should be noted, however, that on certain metallic oxides carbon monoxide is adsorbed irreversibly, and Garner[3] has suggested that it is then incorporated into the surface as a carbonate ion (CO_3''). In such cases, it seems probable that the physical adsorption characteristics are not so markedly changed, and experimental investigation is proceeding on these lines.

Since our last communication, Mr. Reeves, in this laboratory, has repeated the work, using nitrogen instead of krypton, and a similar modification of the isotherm has been observed. It is felt that in our initial discussion we tended to over-emphasize the significance of E_L, the heat of liquefaction. In order to cause a drop in the apparent value of V_m, it is not theoretically necessary that $E_1' < E_L$ but only that E_1' (heat of adsorption on the chemisorbed film) should differ considerably from E_l (heat of adsorption on the bare surface). The 'dual surface' adsorption theory of Walker and Zettlemoyer[4], in which they discuss hypothetical composite isotherms obtained from two surfaces with differing values of the Brunauer–Emmett–Teller parameter c, is of considerable interest in this connexion.

P. F. Tiley
Department of Physical and Inorganic Chemistry,
University of Bristol.

[1] Beebe, R. A., and Stevens, N. P., *J. Amer. Chem. Soc.*, **62**, 2134 (1940).
[2] Stone, F. S., and Tiley, P. F., Faraday Soc. Discussion on Heterogeneous Catalysis, 252 (1950).
[3] Garner, W. E., *J. Chem. Soc.*, 1239 (1947).
[4] Walker, W. C., and Zettlemoyer, A. C., *J. Phys. Chem.*, **52**, 47 (1948).

Application of an Incomplete Block Design to the Assessment of Quality in Cacao

During the course of recent work at the West African Cacao Research Institute, it became necessary to evaluate the products of small-scale fermentations of different types of cacao. Hitherto, samples have been judged for degree of fermentation on the appearance in longitudinal section and condition of testa. These criteria have not been sufficiently discriminating, especially in laboratory fermentation work[1], where in some instances different cacao types have given similar percentages to fully fermented beans.

An attempt has therefore been made to form a local 'taste panel' for assessment of the chocolate flavour of liquors prepared by a standard procedure recommended by the British Food Manufacturing Industries Research Association (Cocoa Panel)[2]. This consists essentially of pre-heating fermented beans at 95–100° C. for one hour before roasting them in a glass-jacketed tube placed in a glycerine bath at 148° C. for 55–60 min., depending on the state of division of the beans. The only difference from the method as recommended is that no sugar has been added to the liquors.

Preliminary work showed that with randomized blocks and 'taster Latin square' designs, panel members had to taste several samples per session, with consequent deterioration in taste perception. A method was sought which would be statistically sound and which required the tasting of only two samples on any one occasion. A given set of samples was arranged in pairs, each sample being matched against every other sample by each taster. Scoring was by pair differences, each taster being asked to distribute ten points between the two samples under test; for example, if the samples were of equal value

five points were allotted to each, the pair difference here being zero. The order of tasting was at random, as was the distribution of the pairs to each taster. The subsequent statistical analysis follows the model laid down by Yates[3].

During the first series, six samples were examined by a panel of six tasters, and the analysis of variance takes the following form, in terms of pair difference throughout :

Table 1

Factor	Degrees of freedom	Sums of squares	Mean square	Variance ratio (F)
Samples	5	88·03	17·61	2·652*
Error	85	563·97	6·64	
Total	90	652·00		

* Significant effect $P < 0{\cdot}05$

If the samples are A, B, C, etc., the 'sample' sum of squares is derived from the expression $\frac{1}{st}(T'_A{}^2 + T'_B{}^2 + T'_C{}^2 \ldots + T'_F{}^2)$. Each of the totals T'_A, T'_B, is the sum of pair differences, no correction for the mean being required, where s is the number of samples, t is the number of tasters and the totals T'_A, etc., are derived from a table of the form shown as Table 2.

Table 2

—	$S(B-A)$	$S(C-A)$	.....	.....	.....
$S(A-B)$	—	$S(C-B$	.....	.....	.....
$S(A-C)$	$S(B-C)$	—	.....	.....	.....
$S(\_-D)$	$S(B-D)$	$S(C-D)$	—	.....	.....
$S(A-E)$	.....	.....	.....	—	.....
$S(A-F)$	.....	.....	.....	.....	—
Totals T'_A	T'_B	T'_C	T'_D	T'_E	T'_F

Mean sample effects are given by $\frac{1}{st}T'_A$, $\frac{1}{st}T'_B$, etc., and these may be presented as mean scores by the addition of the general mean, that is, 5. The standard error of the difference between these values is :

$$\sqrt{\frac{2 \times \text{error mean square}}{st}}.$$

In the first series, bean samples from West African Amelonado, Gold Coast selection $E1$ and Upper Amazon selection $T60$ (Parinari × Nanay) were sorted into fully fermented and insufficiently fermented lots, the lack of 'nibbing' and presence of purple pigments being the criteria of insufficient fermentation. The bulk samples from which these were drawn were obtained from basket fermentations containing 40 lb. wet beans[4]. In the second series, unsorted beans of West African Amelonado and $T60$ were each roasted for 50, 60 and 70 min., and the results are summarized in Table 3 as mean scores.

From these results, it appeared to the local panel that the quality was not affected by the degree of fermentation. With the standard roast (series 1), $T60$ is markedly inferior to the other types. With an increase in roasting time no significant differences could be detected.

It would therefore appear feasible to apply the incomplete block lay-out to the design of a laboratory assessment panel where a large number of samples have to be submitted to subjective tests.

We wish to acknowledge the help given by the Director of Cacao Research and other members of the staff of this Institute who constituted the assessment panels; and also the British Food Manufacturing Industries Research Association Cocoa Panel for supplying details of a method of preparation of liquors.

Table 3

	Series 1 Standard roast (55 min.)		Series 2 Length of roast		
	Under fermented	Fully fermented	50 min.	60 min.	70 min.
W.A.A.	5·56	5·22	5·20	5·27	5·13
$T.60$	4·11	3·00	4·33	5·27	4·80
$E1$	5·61	5·50	—	—	—
S.E. of a difference	±0·607		±0·445		
Significant difference ($P = 0{\cdot}05$)	±1·20		±0·886		

J. A. R. MacLean
Robert Wickens
West African Cacao Research Institute,
Tafo, Gold Coast.
July 14.

[1] MacLean, J. A. R., *Nature*, **166**, 910 (1950).
[2] B.F.M.I.R.A. (private communication).
[3] Yates, F., *Ann. Eug.*, **7**, 121 (1936).
[4] Anon., Pamphlet No. W11758/31 Dept. Agric., Nigeria (June 1947).

Distribution of British Freshwater Amphipoda

Contributions by Hynes[1], Spooner[2] and Reid[3] have recently appeared in *Nature* on this subject. In referring to the spread of *Eucrangonyx gracilis* (S. I. Smith) Spooner states : "It is clear that the canal system has provided this species with an easy means of dispersal. It would be interesting, by a systematic examination of canals, to ascertain the northward limits of its range". It is therefore worthy of placing on record that I found *E. gracilis* in the Huddersfield–Ashton canal at Golcar near Huddersfield (Yorkshire) in July of the present year, this being apparently the most northerly record of this species in Britain to date. In one stretch of the canal it was the only amphipod found after considerable search and was present in some numbers. In an adjoining stretch it was found in company with *Gammarus pulex* (L.) and was considerably outnumbered by this species. Preliminary search of the canal at Marsden, some three miles to the south-west, revealed its presence there, so it is probably distributed throughout that section of the canal which lies to the east of the Pennines.

In an earlier series of communications, Cain and Cushing[4], and Reid[5] directed attention to the apparent increase in range of the semi-terrestrial amphipod *Orchestia bottæ* (M. Edws.). Since that time I have established the existence of a more northerly station for this species, namely, at Huddersfield, and have placed this on record elsewhere[6]. Whether, as Reid suggests, these organisms have been present for some time but have remained undiscovered, or are indeed rapidly spreading northwards, is as yet undecided. Mr. D. M. Reid kindly checked the identity of both the above-mentioned amphipods.

G. Fryer
Department of Biology,
Technical College,
Huddersfield.

[1] Hynes, H. B. N., *Nature*, **167**, 152 (1951).
[2] Spooner, G. M., *Nature*, **167**, 530 (1951).
[3] Reid, D. M., *Nature*, **168**, 126 (1951).
[4] Cain, A. J., and Cushing, D. H., *Nature*, **161**, 483 (1948).
[5] Reid, D. M., *Nature*, **161**, 609 (1948).
[6] Fryer, G., *Naturalist*, No. 835, 148 (1950).

FORTHCOMING EVENTS

Tuesday, September 11—Thursday, September 13

Institution of Mechanical Engineers and the American Society of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1).—Conference on "Heat Transfer".

Tuesday, September 11—Thursday, September 20

Building Research Congress
(at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Division 1: "The Influence of Mechanization and Prefabrication on Techniques and Cost of Building".
(at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2).—Division 2: "Building Materials".
(in Room 140, County Hall, Westminster Bridge, London, S.E.1).—Division 3, Part 1: "The Acoustics of Auditoria and Studios".
(at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1).—Division 3, Part 2: "The Heating and Ventilating of Buildings in relation to Summer and Winter Conditions".
(at the Royal Institution of Chartered Surveyors, 12 Great George Street, London, S.W.1).—Division 3, Part 3: "The Lighting of Buildings".
(at the Royal Institute of British Architects, 66 Portland Place, London, W.1).—Division 3, Part 4: Symposia on "The Problems of Three Specific Types of Buildings".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (with an honours degree in science and/or agriculture, an interest in grassland husbandry and an aptitude for investigational and research work) to the Advisory Officer in Grassland Husbandry, and Assistants (one honours graduate and one non-graduate) in the Chemistry Department, for duties in connexion with soils and land fertility investigations—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (September 14).

Assistant (Grade A) in Physical Chemistry, at Constantine Technical College—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (September 15).

Assistant Chemist (good experience in general analytical work essential, and knowledge and experience of sewage purification or bacteriology and bacteriological and enzyme chemistry an advantage)—The Chief Engineer, Middlesex County Council, Main Drainage Department, Mogden Works, Isleworth, Middx., quoting J.795.T (September 15).

Chemist (Assistant Experimental Officer grade) interested in agricultural research, to do routine sampling and analysis of grass and grassland products—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (September 15).

Electron Microscopist for work on viruses at the Plant Virus Research Unit, Cambridge—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (September 15).

Lecturer in Agricultural Botany—The Registrar, King's College, Newcastle-upon-Tyne (September 15).

Lecturer in Agricultural Sciences, and a Lecturer in Agriculture (farm implements, building construction, etc.), at the Cheshire School of Agriculture, Reaseheath—The Director of Education, County Education Offices, City Road, Chester (September 15).

Lecturer in Inorganic Chemistry in the Department of Chemistry, Colour Chemistry and Dyeing, and a Teacher (with honours degree in mathematics) of Mathematics—The Principal, Technical College, Queen Street South, Huddersfield (September 15).

Lecturer in the Department of Natural Philosophy—The Secretary, The University, Edinburgh (September 15).

Scientists (Grade II) (with good honours degree, or equivalent qualifications, in science or engineering, and some previous research experience) at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/366 (September 15).

Principal Scientific Officer in the Department of Supply, Long Range Weapons Establishment, Adelaide, for the organization and direction of research and development work in the fields of ballistic calculations and mathematical aspects of aerodynamics—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (September 18).

Assistant Lecturer (graduate in physics, chemistry or metallurgy) in Dental Materials—The Registrars, The University, Manchester 13 (September 20).

Assistant (with honours degree in biochemistry, or its equivalent) in Biochemistry—The Secretary, The University, Aberdeen (September 21).

Engineer I at the Ministry of Supply in London, to be responsible for ordering and inspection of plant, planning and production of gauges and cutting tools for all types of ammunition manufacture—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.517/51A (September 24).

Lecturer in Mechanical Engineering, and an Assistant for the Teaching of Chemistry and either Physics or Mathematics to a standard approximately that of the Ordinary Level of the General Certificate of Education—The Principal, Wigan and District Mining and Technical College, Wigan (September 25).

Electrical and Mechanical Engineers (Experimental Officer grade) at a Ministry of Supply research and development establishment near London: (Ref. C.514/51A) Mechanical or Electrical Engineer with thorough experience in the design and use of small electromechanical devices; (Ref. C.515/51A) Mechanical Engineer for tests and trials of small mechanical devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 29).

Senior Scientific Officers or Scientific Officers (Engineers with a knowledge of assembling jig designs and able to appreciate the engineering principles of continuous production machinery) for micro-wave valve development and experimental production at an Admiralty establishment in Essex—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.232/51A (September 29).

Keeper of the Department of Biology—The Director, Museum and Art Gallery, New Walk, Leicester, endorsed 'Keeper of Biology' (September 30).

Mechanical Engineer (with headquarters in London) to test and report upon various items of mechanical equipment—The Secretary, Forestry Commission, 25 Savile Row, London, W.1 (October 1).

Physical Chemist for investigations of high molecular weight substances by ultracentrifugation—The House Governor, Royal Cancer Hospital, Fulham Road, London, S.W.3 (October 1).

Senior Experimental Officers (with H.S. Certificate with Mathematics or a science subject as a principal subject, or an equivalent qualification, and considerable technical experience of the raw material resources of the Colonial territories which are of plant or animal origin) in the Colonial Products Advisory Bureau (Plant and Animal)—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4067/51 (October 4).

Chair of Mining—The Registrar, The University, Sheffield (October 6).

Director of the Auckland Art Gallery, New Zealand—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (Auckland, October 31).

Electrical Engineer and Manager to the Antigua Electricity Board—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28838.B.

Graduate Scientists to take part in research and for training in the scientific control of brewery operations in the Foundation's physical, chemical, analytical, biological or brewing laboratories—The Director, Brewing Industry Research Foundation, Nutfield, Surrey.

Graduates in Fuel, Chemistry, Physics or Chemical Engineering, for laboratory and/or plant work: Principal or Senior Scientific Officers (with good honours degree) as research section leaders, and Scientific and Experimental Officers for work in laboratory or on coke ovens and iron and steel plants—The Director, British Coke Research Association, 74 Grosvenor Street, London, W.1.

Junior Assistant Physicist—The Secretary, South Manchester Hospital Management Committee, Christie Hospital and Holt Radium Institute, Manchester 20.

Mathematician (M. or F., with honours degree, and knowledge of engineering, physics or chemistry an advantage)—The Secretary (Ref. A.28), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

Physical or Inorganic Chemist (preferably with one or two years research experience) to work on the surface structure of inorganic pigments, and a Physical Chemist (with a good knowledge of surface chemistry) for work on the physico-chemical relationships between pigments and organic media in surface coating materials—The Director, Paint Research Station, Waldegrave Road, Teddington, Middx.

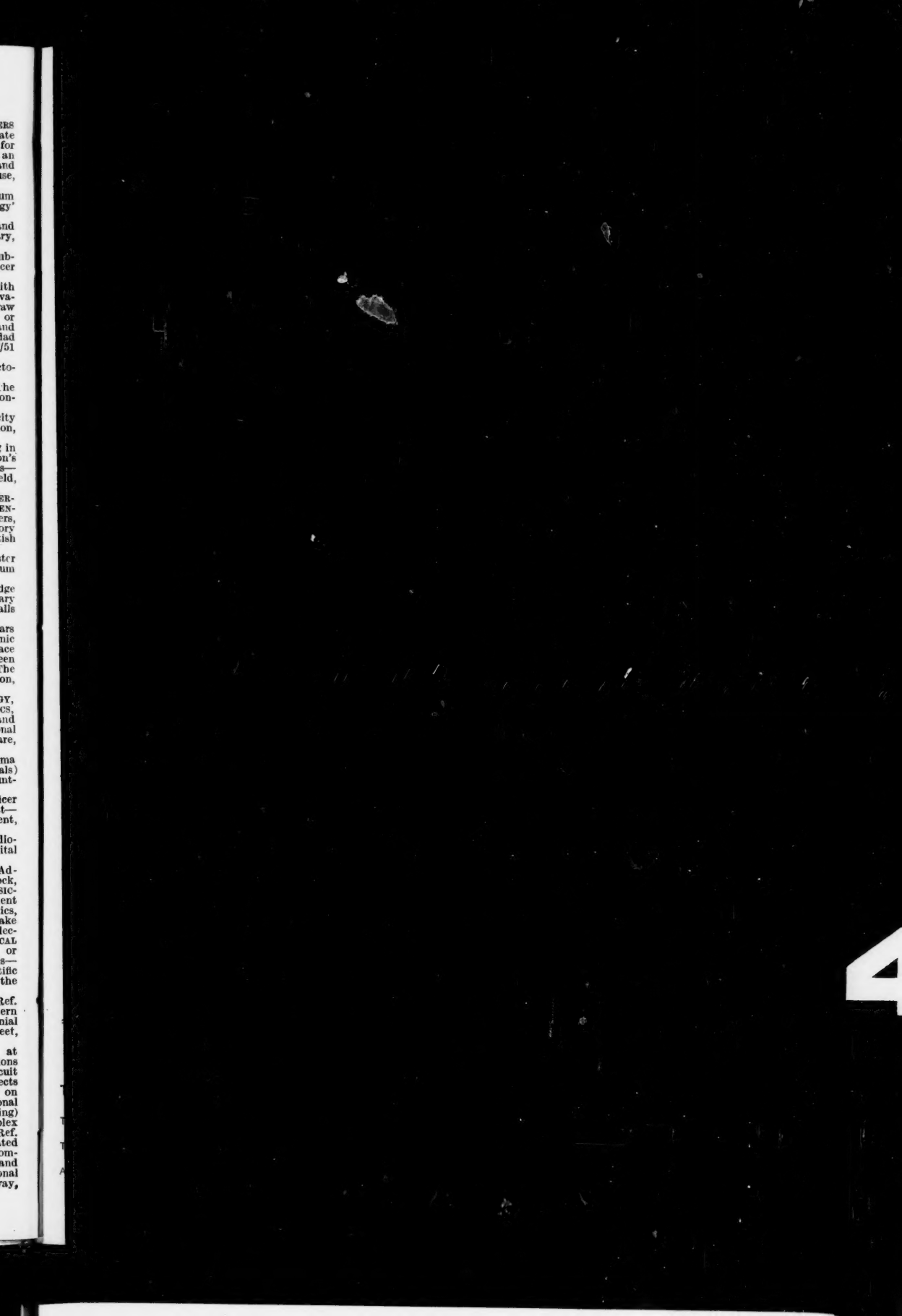
Professors of Mathematics, Physics, Chemistry, Zoology, Botany, Geography, Psychology, Philosophy, Economics, English, Political Science and International Relations, and History, at the University of Karachi, Pakistan—The Educational Attache to the High Commissioner for Pakistan, 39 Lowndes Square, London, S.W.1.

Regional Trials Officer (with a university degree or diploma in agriculture and/or biology, and experience of conducting field trials)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Senior Plant Pathologist (Senior Principal Scientific Officer grade) at the West African Cocoa Research Institute, Gold Coast—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Senior Physicist, and an Assistant Physicist, to the Radiotherapy Department—The Group Secretary, Wolverhampton Hospital Management Committee, Royal Hospital, Wolverhampton.

Senior Scientific Officers and Scientific Officers at Admiralty experimental establishments in the vicinity of London, Baldock, Greenoch, Haslemere, Portsmouth, Rosyth and Weymouth: Physicists (Ref. A.336/50A) capable of undertaking research or development in general physical problems, electronics, acoustics or thermodynamics, Electrical Engineers (Ref. D.367/50A) qualified to undertake research, development or design in telecommunications, radar, electronics, instrumentation or light electrical mechanisms, Mechanical Engineers (Ref. C.631/50A) capable of design, development or research work in light mechanisms, structures or hydrodynamics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Structural Engineer (Public Works), Northern Rhodesia (Ref. 27322/222), and a Sanitary Engineer (Public Works), Northern Rhodesia (Ref. 27322/221)—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.

Technical Authors at a Ministry of Supply establishment at Chessington for the preparation of official instructional publications in the following groups: (Ref. D.376/51A) handbooks and circuit diagrams on the theoretical and practical (including servicing) aspects of airborne and ground electrical and electronic equipment, or on complete installations in aircraft, (Ref. D.378/51A) instructional publications on the theoretical and practical (including servicing) aspects of aircraft gun sights, bomb and torpedo sights, or complex types of aircraft navigation and computing instruments, (Ref. D.377/51A) instructional publications embracing aircraft and associated airborne and ground equipment, including airframes, electrical components and installation, air armaments, mechanical transport and airfield construction plant—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.